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EXPERIMENTAL TAGGING OF YOUNG MUSKRATS FOR PURPOSES OF STUDY[1]

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Metal ear tags have been used for the marking of domestic mammals for some years, but their use on wild mammals, so far as we are aware, is of rather recent origin. Aldous (1937), for one, found ear tags very satisfactory in his studies of the snowshoe hare (*Lepus americana*); and the Iowa Fish and Game Commission ear-tagged considerable numbers of young red foxes (*Vulpes fulva*) during 1933 and 1934 (Errington and Berry, 1937).[2]

Preliminary work on the life history of the muskrat (*Ondatra zibethica*), in northwest Iowa marshlands during the summer of 1934, emphasized the need for some method of marking the young of the various litters that were to be kept under observation. It was decided to experiment the following season with the same style of tag tried out on the foxes.

The muskrat, however, even as an adult, does not have a large enough external ear to allow the fastening of ear tags of the sizes conveniently available to us, so we considered the alternative of attaching the tag to the skin on the back of the animal. A position between the shoulder blades seemed to offer the greatest promise, as there the tag would be least likely to get in the animal's way and would also be out of reach of its teeth, if not its claws.

The tags were of aluminum, stamped with serial numbers and the abbreviated name and address of the Iowa Fish and Game Commission, and, when fastened, took the form of doubled strips of metal 24 mm. in length and 5 mm. in width. As supplied commercially (Fig. 1-A), they were not exactly as we wanted them for insertion under the muskrat's skin, but we found that they could be easily bent with the fingers to suit our purpose (Fig. 1-B and 1-C).

In 1935 and 1936, we placed a total of 463 tags on young muskrats ranging in ages from 4 days to approximately 2 months and averaging close to 16 days. Tagging was practically restricted to Mud and Round Lakes, two marshes near Ruthven, Iowa. Studies on Mud Lake, an area of about 400 acres largely in private ownership, were permitted through the courtesy of the

[1] Journal Paper No. J 468 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 498.

Iowa State College in cooperation with the U. S. Biological Survey, the American Wildlife Institute, and the Iowa Conservation Commission.

[2] Since this manuscript was prepared, Dr. W. B. Bell of the Biological Survey has written "... beginning in 1923 ear tags were used to a limited extent in marking elk in the Jackson Hole country and in Yellowstone National Park." (Letter, July 8, 1937.)

Mud Lake Fur Farm. Round Lake is a state wildlife refuge of about 450 acres upon which the muskrat investigations were expressly encouraged and aided by the Iowa Conservation Commission.

On Mud Lake, 129 young in 27 litters were tagged from May 25 to June 23, 1935; and 210 young in 59 litters were tagged on Round Lake from June 25 to July 22. Aside from one young tagged north of Mud Lake in a pothole which later dried up, all of the tagging in 1936 was done on Round Lake, 123 young in 52 litters having been tagged there from May 13 to July 6.

Despite experimentation that was carefully planned and checked, much of the progress made in working out a satisfactory technique was a matter of trial and error. The techniques used in 1935 were on the whole decidedly inferior to those used in 1936. Not only did we find evidence of the young sloughing their tags in 1935, but a number of young seemed to be suffering ill effects from the tagging. By 1936, the obvious weaknesses in our tagging methods appeared to have been pretty well eliminated.

We shall, in this paper, try to confine our discussion to those points of probable greatest interest to investigators

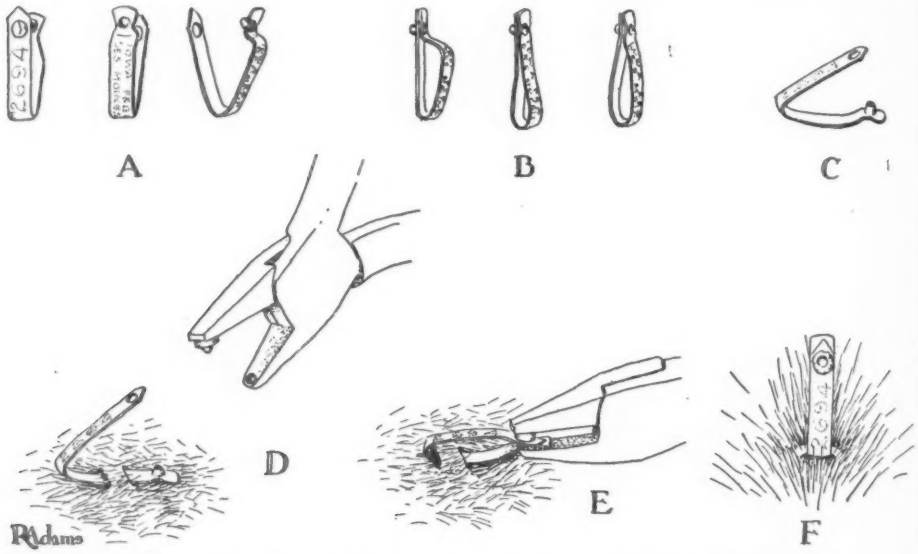

Fig. 1. Drawings to illustrate steps in the manipulation of tags.

A. Views of the unaltered tag as commercially supplied.
B. Successive stages in the alteration of a tag for use on young muskrats.
C. Tag altered, open, and ready for use.
D. Tag inserted in skin of young muskrat.
E. Sealing of the tag.
F. Appearance of the tag on adult muskrat tagged while young. Note especially the bridge of living skin by which the tag is attached.

Drawings by Ruth Dudgeon Adams

TABLE 1

DATA ON MUSKRATS TAGGED AS YOUNG AND RECOVERED WHEN NEARLY GROWN OR AS ADULTS

Serial number of Iowa F. & G. Comm. Tag	Where and when tagged	Where and when recovered and distance from where tagged	Length, weight and known or calculated age when tagged	Length, weight and known or calculated age when recovered	Sexual advancement when recovered on basis of macroscopic examination of gonads
2981	S. central edge of Mud Lake, June 15, 1935	Central Mud Lake, Jan. 2, 1936. About 200 yds.	203(?) mm.[1] 85(?) g. 16 days	Medium sized, as reported by trapper. 217 days	Not examined
2487	N. W. corner of Round Lake, July 5, 1935	Farmer's hog house, early in winter of 1936–37. About 21 miles	145(?) mm.[2] 45(?) g. 8(?) days	No size data reported. Probably between 500 and 550 days	Not examined
2647	N. W. corner of Round Lake, May 14, 1936	Ditch S. of Ruthven, about Nov. 15, 1936. About 4 miles	166 mm. 65 g. 11 days	No size data reported by trapper. 196(?) days	Not examined
2654	N. central edge of Round Lake May 24, 1936	N. E. part of Round Lake, Dec. 14, 1936 About 630 yds.	191 mm. 76 g. 14 days	535 mm. 826 g. 218 days	Immature male (testes: 7×6×4 mm.)
2670	S. central edge of Round Lake, May 27, 1936	E. central Round Lake where drowned in storm about Apr. 25, 1937. About 800 yds.	194 mm. 80 g. 12 days	560(?) mm. 950(?) g. 345 days	Carcass had been partly eaten by scavengers when found April 28, 1937, but was thought to be that of a sexually active male.
2678	E. center of Round Lake, May 27, 1936	E. central Round Lake, Dec. 15, 1936. About 100 yds.	236 mm. 110 g. 19 days	535 mm. 853 g. 222 days	Immature female
2688	N. E. corner Round Lake, June 7, 1936	N. E. corner Round Lake, Nov. 5, 1936. About 45 yds.	188 mm. 73 g. 13 days	494 mm. 760 g. 164 days	Immature male
2693	S. central edge Round Lake, June 8, 1936	S. central Round Lake, Dec. 9, 1936. About 260 yds.	178 mm. 65 g. 12 days	563 mm. 960 g. 197 days	Immature but evidently maturing male (testes: 9×6×5 mm.)[3]
2695	N. central edge of Round Lake, June 9, 1936	N. central Round Lake, Dec. 12, 1936. About 180 yds.	212 mm. 87 g. 16 days	516 mm. 665 g. 202 days	Immature female

[1 and 2] Estimated.

[3] Testes of mature males at this season measure about 15×9×5 mm.

TABLE 1 (*Continued*)

Serial number of Iowa F. & G. Comm. Tag	Where and when tagged	Where and when recovered and distance from where tagged	Length, weight and known or calculated age when tagged	Length, weight and known or calculated age when recovered	Sexual advancement when recovered on basis of macroscopic examination of gonads
2696[4]	N. central edge of Round Lake, June 9, 1936	N. central Round Lake, Dec. 13, 1936. About 195 yds.	213 mm. 87 g. 16 days	499 mm. 800 g. 203 days	Immature female
2702	N. central edge of Round Lake, June 9, 1936	W. central Round Lake, Dec. 13, 1936. About 500 yds.	166 mm. 58 g. 10 days	573 mm. 800(?) g.[5] 197 days	Immature but evidently maturing male
2719[6]	N. E. corner Round Lake, June 19, 1936	N. E. corner Round Lake, Nov. 7, 1936. About 60 yds.	275 mm. 162 g. 25 days	501 mm. 731 g. 166 days	Immature male
2720	N. central edge of Round Lake, June 20, 1936	N. central Round Lake, Nov. 7, 1936. About 300 yds.	239 mm. 112 g. 21 days	471 mm. 715 g. 161 days	Immature female
2725	S. central edge of Round Lake, June 22, 1936	S. central Round Lake, Dec. 14, 1936. About 250 yds.	208 mm. 73 g. 15 days	518 mm. 620 g. 190 days	Immature male (testes: 7×5×4 mm.)
2727	S. central edge of Round Lake, June 22, 1936	S. central Round Lake, Dec. 14, 1936. About 160 yds.	175 mm. 68 g. 15 days	493 mm. 826 g. 190 days	Immature male (testes: 8×6×4 mm.)
2732	W. central Round Lake, June 23, 1936	W. central Round Lake, Dec. 11, 1936. About 225 yds.	185 mm. 85 g. 14 days	544(?) mm.[7] 968 g. 185 days	Immature male (testes: 8×5×4 mm.)

[4] 2696 was a litter mate of 2695.
[5] Animal had been partly eaten in a trap by a mink, so weight was estimated on the basis of general size.
[6] 2719 was a litter mate of 2688.
[7] Animal had lost part of its tail when young, which resulted in the reduction of its length to an actual 471 mm. The addition of the estimated difference of 73 mm. gives the 544(?) mm. as near to what would probably have been its length otherwise.

who may themselves be confronted by problems similar in nature to ours.

TYPES OF DATA OBTAINED THROUGH TAGGING

Marking of wild animals commonly has for its chief purpose the securing of information on the movements of individuals. In this respect, our tagging data have been fairly, though not startlingly, productive. Field studies had already indicated that the young were likely—at least until the following breeding season—to remain in their natal localities or to establish their own home ranges not far away. Recoveries

of tagged young from early swimming to nearly grown sizes substantiated this concept.

The data presented in Tables 1 and 2 illustrate the tendency of young of the year to stay within familiar territory. Direction of movement is evidently influenced by size and shape of occupied portions of the marsh, by seasonal changes in depth of water and distribution of food in the occupied portions, by local and surrounding population densities, and by tolerances and intolerances of muskrats in residence.

Movement of dependent young by adults also takes place from time to time. This was particularly noted in the course of an intensive study on Round Lake, which entailed daily examination of all lodges, feeding places, and litters on one tract of about 15.8 acres for 19 consecutive days, July 6 to 24, 1935. Some of the movement of litters by adults from one lodge to another was unquestionably in response to previous disturbance by the observers, but we have frequently encountered evidence of litter movement of this sort on first visits to given sections of a marsh. Much was learned without tagging but through this means was demonstrated the transfer of litters between lodges as far apart as 60 yards, the splitting up and recombination of litters in the same lodge or in different lodges, and, occasionally, the regular quartering of part of a litter in one lodge and the rest in another.

Mortality of young muskrats because of attacks by adults has been conspicuous throughout the investigations in northwest Iowa, and tagging has done much to clarify certain aspects of this lethal friction. The broad statement may be made that young are subject to attack almost anywhere in relation to their natal localities and at almost any age. Sometimes they may be killed as helpless, blind young in or about the nests in which they are being raised, but more often they get into trouble with their elders during post-weaning development, seemingly by intrusion into places where they are not wanted. No. 2658, for example, was fatally slashed apparently by its own mother which was at the time giving birth, or about to give birth, to a new litter.

Perhaps the most significant data to come out of the tagging program were those relating to the growth rates of individual young. A later paper will be devoted to this phase of the investigation, but it may be remarked in advance that tagging has been a particularly useful means of securing developmental data on young of more active sizes (Table 2). The data on young nearing full adult sizes (Table 1) not only illustrate the rate of growth of individuals of known ages, but the condition of the gonads of these young has pertinent bearing upon the old question of whether the young of early litters themselves give birth to young in the same breeding season.

PROGRESS OF THE EXPERIMENTAL STUDY

The tagging on Mud Lake in the early summer of 1935 was not accompanied by repeated handling of the young, but the marsh was heavily trapped by employees of the Mud Lake Fur Farm during the trapping season of the following fall and winter. The re-

TABLE 2

RECOVERIES OF YOUNG TAGGED MUSKRATS ILLUSTRATING DISTRIBUTION AT STAGES OF EARLY INDEPENDENCE

Serial number	Size, age, and date when tagged	Size, age, and date when recovered	Distance from site of tagging when recovered	Circumstances of recovery
2523	215(?) mm., 90(?) g., 18 days. May 27, 1935	305(?) mm., 200(?) g., 35 days. June 13, 1935	Same lodge	Dead, apparently from disease, on outside of lodge
2386	215(?) mm., 90(?) g., 15 days. June 27, 1935	267 mm., 143 g., 26 days. July 8, 1935	Vicinity of same lodge	Captured alive and released
2406	200(?) mm., 75(?) g., 13 days. July 2, 1935	254 mm., 133 g., 23 days. July 12, 1935 254 mm., 128 g., 24 days. July 13, 1935	Same lodge Lodge 40 yds. distant	Captured alive and released Captured alive and released
2440	230(?) mm., 100(?) g., 19 days. July 4, 1935	261 mm., 150 g., 29 days. July 14, 1935	Same lodge	Captured alive and released
2480	240(?) mm., 115(?) g., 24(?) days. July 4, 1935	267 mm., 173 g., 36(?) days. July 16, 1935	Same place	Captured alive and released
2485	240(?) mm., 115(?) g., 24(?) days. July 4, 1935	305 mm., 175 g., 40(?) days. July 20, 1935	Same lodge	Dead, apparently of wounds inflicted by another muskrat
2468	195 mm., 81 g., 14 days. July 6, 1935	254 mm., 136 g., 27 days. July 19, 1935	Lodge 25 yds. distant	Captured alive and released the last time after almost daily handling since tagging
2469	191 mm., 78 g., 14 days. July 6, 1935	261 mm., 140 g., 30 days. July 22, 1935	Lodge 25 yds. distant	Captured alive and released for last time after daily handling since tagging. Found in dying condition next day with tail nearly severed at base by a bite from another muskrat
2611	197 mm., 75 g., 15 days. July 7, 1935	261 mm., 135 g., 30 days. July 22, 1935	Coot's nest about 35 yds. distant	Captured alive and released for last time after almost daily handling since tagging
2612	197 mm., 80 g., 15 days. July 7, 1935	264 mm., 152 g., 30 days. July 22, 1935	Coot's nest about 35 yds. distant	Captured alive and released for last time after daily handling since tagging
2646	172 mm., 65 g., 11 days. May 14, 1936	254 mm., 137 g., 23 days. May 26, 1936	Same lodge	Captured alive and released
2647	166 mm., 65 g., 11 days. May 14, 1936	228 mm., 126 g., 23 days. May 26, 1936	Same lodge	Captured alive and released (see Table 1 for later recovery)
2651	223 mm., 90 g., 17 days. May 24, 1936	287 mm., 185 g., 31 days. June 7, 1936	Lodge 60 yds. distant	Dead, apparently from wounds inflicted by another muskrat

TABLE 2 (*Continued*)

Serial number	Size, age, and date when tagged	Size, age, and date when recovered	Distance from site of tagging when recovered	Circumstances of recovery
2652	213 mm., 95 g., 17 days. May 24, 1936	280 mm., 128 g., 31 days. June 7, 1936	Lodge 60 yds. distant	Dead, in poor condition and apparently from disease
2656	208 mm., 96 g., 17 days. May 25, 1936	297 mm., 220 g., 48 days. June 25, 1936	Rushy debris on shore about 10 yds. distant	Dead, apparently from wounds inflicted by another muskrat
2657	213 mm., 90 g., 17 days. May 25, 1936	299 mm., 197 g., 36 days. June 13, 1936	Same lodge	Captured alive and released
2658	213 mm., 85 g., 16 days. May 25, 1936	293 mm., 222 g., 35 days. June 13, 1936	Outside of a lodge 20 yds. distant	Found just after it had been severely slashed about hind-quarters by adult. It was dead next day in lodge where tagged. (See text for further discussion)
2660	210 mm., 85 g., 16 days. May 25, 1936	288 mm., 172 g., 29 days. June 7, 1936	Water outside same lodge	Captured alive and released
		297 mm., 193 g., 35 days. June 13, 1936	Same lodge	Captured alive and released
2673	229 mm., 101 g., 20 days. May 27, 1936	306 mm., 200 g., 34 days. June 10, 1936	Same lodge	Captured alive and released
2680	169 mm., 62 g., 11 days. May 27, 1936	270 mm., 151 g., 27 days. June 12, 1936	Lodge 30 yds. distant	Captured alive and released
2681	175 mm., 65 g., 11 days. May 27, 1936	293 mm., 170 g., 27 days. June 12, 1936	Lodge 30 yds. distant	Captured alive and released
2683	229 mm., 105 g., 22 days. June 5, 1936	275 mm., 152 g., 29 days. June 12, 1936	Same lodge	Captured alive and released
2687	187 mm., 58 g., 13 days. June 7, 1936	213 mm., 85 g., 18 days. June 12, 1936	Same lodge	Captured alive and released
		252 mm., 130 g., 25 days. June 19, 1936	Same lodge	Captured alive and released
2691	204 mm., 77 g., 15 days. June 7, 1936	271 mm., 105 g., 20 days. June 12, 1935	Same lodge	Captured alive and released
		287 mm., 163 g., 27 days. June 19, 1936	Same lodge	Captured alive and released
2702	165 mm., 58 g., 10 days. June 9, 1936	191 mm., 73 g., 14 days. June 13, 1936	Same lodge	Captured alive and released
		217 mm., 95 g., 16 days. June 15, 1936	Same lodge	Captured alive and released
		225 mm., 105 g., 18 days. June 17, 1936	Same lodge	Captured alive and released
		254 mm., 130 g., 22 days. June 21, 1936	Same lodge	Captured alive and released. (See Table 1 for later recovery)

TABLE 2 (*Continued*)

Serial number	Size, age, and date when tagged	Size, age, and date when recovered	Distance from site of tagging when recovered	Circumstances of recovery
2703	194 mm., 80 g., 14 days. June 10, 1936	275 mm., 162 g., 25 days. June 21, 1936	Water outside lodge 5 yds. distant	Captured alive and released
2713	245 mm., 97 g., 20 days. June 12, 1936	263 mm., 121 g., 27 days. June 19, 1936	Same lodge	Captured alive and released
2716	254 mm., 115 g., 22 days. June 13, 1936	274 mm., 148 g., 29 days. June 20, 1936	Same lodge	Captured alive and released
2717	276 mm., 155 g., 24(?) days. June 18, 1936	287 mm., 166 g., 25(?) days. June 19, 1936	Same lodge	Captured alive and released
2731	200 mm., 95 g., 14 days. June 23, 1936	260 mm., 155 g., 19 days. June 28, 1936 296 mm., 164 g., 26 days. July 5, 1936	Same lodge Rush pile 50 ft. distant	Captured alive and released Captured alive and released. Tip of tail had been chewed off because of a skin disease
2732	185 mm., 85 g., 14 days. June 23, 1936	229 mm., 120 g., 19 days. June 28, 1936 260 mm., 140 g., 26 days. July 5, 1936	Same lodge Rush pile 50 ft. distant	Captured alive and released Captured alive and released. Tip of tail had been severely chewed because of a skin disease. (See also Table 1 for later recovery)
2735	200 mm., 82 g., 15 days. June 24, 1936	217 mm., 93 g., 19 days. June 28, 1936 254 mm., 103 g., 26 days. July 5, 1936	Same lodge Same lodge	Captured alive and released Captured alive and released
2742	223 mm., 94 g., 18 days. June 27, 1936	229 mm., 98 g., 19 days. June 28, 1936 225 mm., 103 g., 26 days. July 5, 1936	Same lodge Same lodge	Captured alive and released Captured alive and released. Animal at this handling was suffering from skin disease.
2761	250 mm., 121 g., 21 days. July 5, 1936	320(?) mm., 250(?) g., 46 days. July 30, 1936	Rush raft about 125 yds. distant	Not handled but approached close enough while asleep to read number on tag. Size was estimated on basis of experience.

covery of only one tag—No. 2981 in Table 1—from nearly two thousand trapped muskrats makes it improbable that many of the 129 tagged young were still bearing their tags as adults.

On the other hand, the 1935 tagging on Round Lake was attended by intensive summer study, though followed by no legal trapping in the fall and winter. As a result, we have a preponderance of data on the young a comparatively short time after tagging

but no returns of tags from adults except No. 2487 of Table 1 which was reported killed about 21 miles away in a farmer's hog house the second winter after tagging. A great deal of illegal spearing through the lodges was said to have occurred on Round Lake during the winter of 1935–36, and this may have eliminated a large proportion of whatever tag-bearing animals may have been living on the refuge.

Of the uncatchable tagged young to be seen on the marsh by the middle of July, 1935, some were sickly looking and undersized and seemed mainly occupied with scratching at their tags with their hind feet. Some sloughed tags were found on the butts of old lodges, and individuals were seen with fresh tag scars or tags about to some off.

Tag wounds of some individuals—especially those tagged when less than a week old—seemed to heal slowly and show conspicuous suppuration about the edges, though rarely more than traces of inflammation beneath. One young, tagged at the age of about 13 days, was found 10 days later in a dying condition from myiasis under the tag. Members of certain tagged litters were observed to grow normally for a few days, then to lose weight and die or disappear. In the light of present interpretation of symptoms described in the field notes, much of this unthriftiness and mortality was plainly due to disease; but at the time it was attributed to the tagging.

In brief, while many tagged young developed in a perfectly normal manner with their tags remaining well attached, we were dissatisfied with our tagging technique so far as it had progressed by the middle of July, 1935. The tags on two litters had been chewed more or less by adults, but the main difficulties could be blamed upon faults of the technique itself.

It became apparent that the killing of skin tissue within the loops of the sealed tags was a major source of trouble and that this in turn was largely the result of the inclusion of too much skin or the leaving of too little space between the upper and lower parts of the tags. Tags proving to be most cleanly and firmly attached were never held by more than a small piece of skin, anyway; and skin inclosed in excess of this minimum amount was almost sure to die and slough, possibly to the detriment of the animals or the loss of their tags.

Steps were taken to remedy shortcomings in our methods as soon as they were recognized. From July 13 to 22, 1935, all young (27 of the season's total of 210 on Round Lake) were tagged according to a technique by which only a small strip of skin was left within the loop of the tag. Tagging was discontinued after July 22 for 1935 so as not to expose the young muskrats unnecessarily to the sarcophagid flies which seemed to be reaching great abundance on the marsh about that time.

In 1936, technique experiments were continued throughout the summer but with little departure from the procedure that showed the greatest promise in 1935. As a rule, only half of the members of each litter were tagged, to allow the use of the untagged young as checks at subsequent handlings. Substantial progress toward the improvement of our technique is indicated by the comparative data summarized in Table 3.

In other respects, also, the produc-

tiveness of the 1936 tagging program on Round Lake was highly gratifying. The intensive field work of the summer was followed by the taking, under supervision of the Conservation Commission, of 181 muskrats in November and December, and, of these animals, 12 bore tags. The trappers employed by the Commission were Messrs. Verl Black and Roy Walrod who were chosen for their cooperativeness and interest in the objectives of the research and who recorded sites of capture and other data pertaining to the specimens.

TABLE 3
IMPROVEMENT OF TAGGING TECHNIQUE AS REFLECTED BY MORE OR LESS COMPARABLE DATA[1]

Type of technique	Tags placed yielding any sort of data	Tags recovered from adults or adult sizes	Tags recovered from dead young	Young handled or seen in life after tagging			Young seen having lost or about to lose tags	Young recorded showing probable ill effects from tagging
				Number tagged young handled	Average times handled after tagging	Av. interval between tagging and last handling		
Inferior or experimental. Mud Lake, 1935	22 or 17.1% of 129	1 0.8%	10[2] 7.8%	11 8.5%	1.1	2.1 days	0	0
Inferior or experimental. Round Lake, 1935	49 or 23.3% of 210	1 0.5%	10 4.8%	41 19.5%	3.7	7.3 days	8 3.8%	16 7.6%
Improved. Round Lake, 1936	51 or 41.5% of 123	14 11.4%	8 6.5%	34 27.6%	1.3	8.6 days	1 0.8%	1 0.8%

[1] Not all data presented may be judged comparable. The lack of data from recoveries of adults following the 1935 tagging on Round Lake is not unexpected as no legal trapping was done there in the winter of 1935–36. Similarly, the tagging on Mud Lake was neither followed nor accompanied by the repeated visiting and intensive studies that characterized the summer work on Round Lake.

[2] Misleadingly high, as 7 of the 10 were members of a litter that starved after the death of the mother.

TAGGING TECHNIQUE—DESCRIPTION AND DISCUSSION

A description of what we consider up-to-date technique for the tagging of young muskrats may be of some value to other or prospective workers.

Tags need not be of the identical design as those which we used (Fig. 1-A) but they should be of a type to lie as flatly as possible on the animal's back and to display the serial number uppermost so that it may be read from a distance of a few feet. This latter feature is important, for occasionally an observer may approach closely a tame or a sleeping individual, even though he may not be able to capture or to handle it. Flat-lying tags are preferable, as they become less abraded from contact with the walls of the muskrat burrows.

It was to keep our tags flat-lying and legible that we adopted the practice of altering them as illustrated by Fig. 1. In Fig. 1-B, the commercial tag was

A. Making th
B. The tag in
C. Sealing of
D. The young

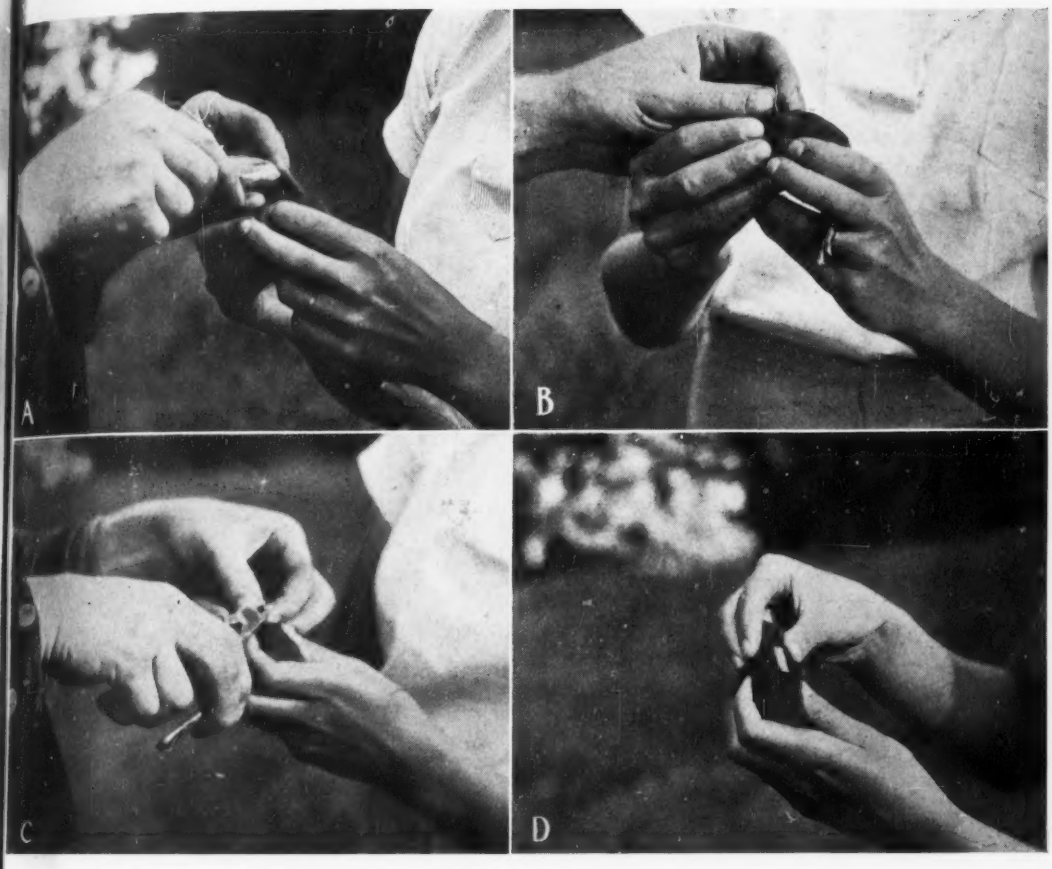

Plate 4. The tagging of a young muskrat.

A. Making the incisions in the skin of the back between the shoulder blades.
B. The tag inserted and ready to be closed and sealed.
C. Sealing of the tag.
D. The young muskrat tagged and ready to be returned to its nest.

Photos by R. J. Bailey

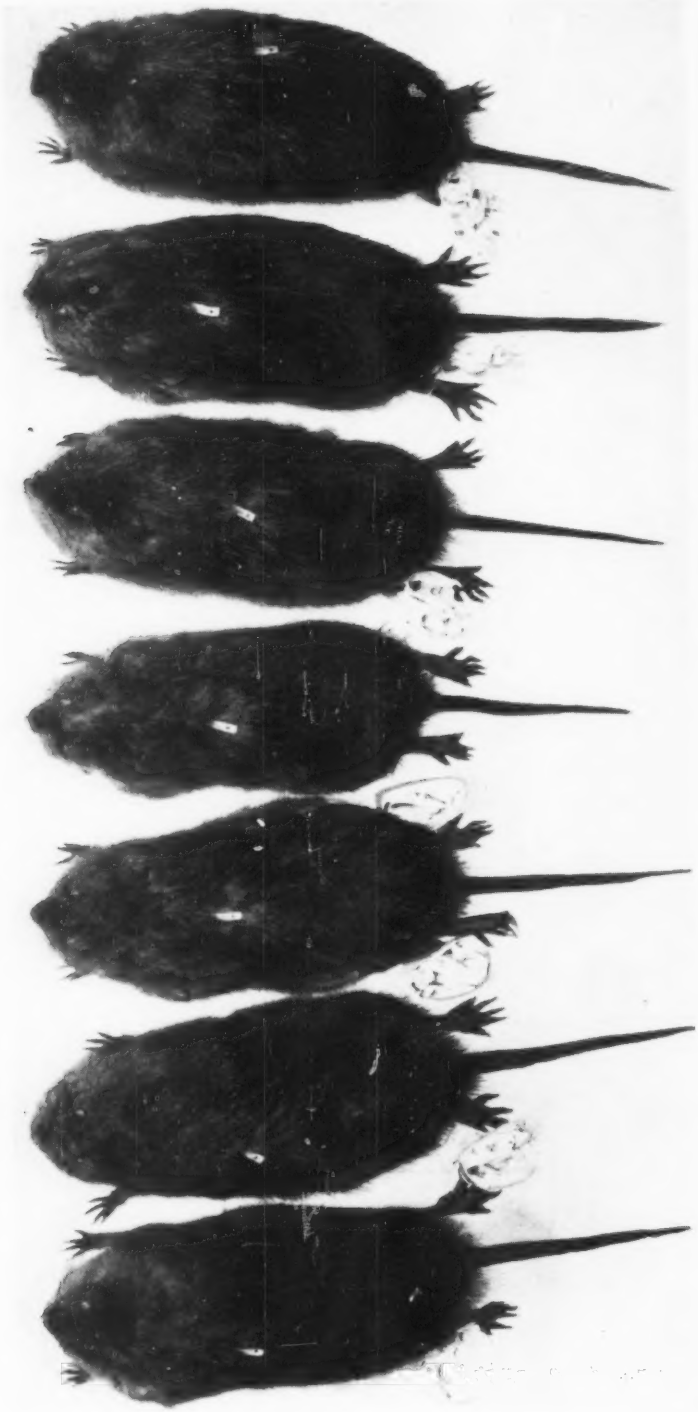

Plate 5. Skins of December-caught muskrats tagged while young during the previous summer.

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first closed, with the conical projection of one end fitting into the hole in the other. Next the tag was flattened to reduce the undesirable shoulder, later to be expanded as much as necessary to leave plenty of space for skin and fur. Finally, the free ends were spread again and the tag was ready for use (Fig. 1-C).

When an animal is in possession to be tagged, one person should do the holding and the other should affix the tag. It is often something of a feat to pick up a strong and resentful young muskrat without being bitten, but, once in hand, the animal may be firmly grasped about head and hindquarters in such a way as to lessen its struggles and to prevent it from inflicting damage. The person having hands free may then make the proper incisions (Pl. 4-A), slip the cone end of the tag into one incision and out of the other (Fig. 1-D; Pl. 4-B), and join the two ends with the sealing pliers (Fig. 1-E; Pl. 4-C). The tag with sealed end pointing backwards is looped under a small strip of skin, and the young animal is ready to be returned to its nest (Pl. 4-D).

In our estimation, the success or failure of the technique hinges principally on the making of the incisions. We have found in practice that the most satisfactory incisions are smaller than the end of the tag they are to admit, so that the cut skin fits snugly around the metal. The space between the anterior and posterior incisions should not exceed 10 mm. and should preferably be less, down to about 5 mm. especially for younger sizes of muskrats. Tags well placed on young animals will be retained on the backs of larger young or adults (Pl. 5) by small bridges of living skin, underneath which the cut skin tissue will have closed and healed (Fig. 1-F).

The optimum age for tagging seems to be between 12 and 15 days, when the young average roughly between 70 and 90 g. in weight and 180 and 200 mm. in length. At this stage they are sluggish and docile enough to be caught and handled and rugged enough easily to bear the tagging. The example pictured in Pl. 4 was about 10 days old, 64 g., and 169 mm., and was near the minimum size for good tagging results. Young of about 8 days have been tagged with evident success (No. 2487, Table 1), but we do not recommend tagging these small sizes, even if the space between incisions be shortened. One 4 day animal died apparently from the shock of tagging, and it is suspected that some others also were tagged while too young.

The tagging itself does not appear to be a drastic ordeal for muskrats of suitable sizes. The animals may squirm or whimper to some extent while the incisions are made and the ends of the tags inserted under their skins, but the only part of the tagging one would think painful is completed—if the operator is dextrous—in a few seconds.

We have no way of judging the possible adverse effects upon the young muskrats of annoyance because of the tags, but healthy young may recover with great rapidity from wounds far more severe than tagging incisions. One of about 8 days was found with a forefoot nearly severed by a wound received possibly two or three days previously. Although the broken ends of the radius and ulna were exposed and separated,

TABLE 4

COMPARATIVE GROWTH OF TAGGED AND UNTAGGED YOUNG IN SPECIFIC MUSKRAT LITTERS

Field number of lodge occupied by litter	Data on young at time of tagging			Data on young at time of last comparison			Growth of young since date of tagging	
	Date of tagging and age of young	Average size of tagged young	Average size of young left untagged	Date of last comparison of litter members	Average size of tagged young	Average size of young left untagged	Average gain of tagged young	Average gain of young left untagged
1935 #NE6	July 6 6 days	135 mm., 34 g., av. 3 young	137 mm., 36 g., av. 2 young	July 8	145 mm., 44 g., av. 3 young	152 mm., 45 g., av. 2 young	10 mm., 10 g., av. 3 young	15 mm., 9 g., av. 2 young
1936 #85	May 14 11 days	168 mm., 65 g., av. 2 young	166 mm., 65 g., av. 2 young of nearly equal size	May 26	246 mm., 132 g., av. 2 young	244 mm., 127 g., for 1 young	78 mm., 67 g., av. 2 young	78 mm., 62 g., for 1 young
1936 #32 and #35	June 7 15 days	204 mm., 75 g., av. 3 young	200 mm., 70 g., av. 3 young	June 12	253 mm., 102 g., av. 3 young	227 mm., 96 g., av. 3 young	49 mm., 27 g., av. 3 young	27 mm., 26 g., av. 3 young
1936 #29	June 7 13 days	188 mm., 66 g., av. 2 young 188 mm., 58 g., for 1 young	187 mm., 60 g., for 1 young 187 mm., 60 g., for 1 young	June 12 June 19	216 mm., 93 g., av. 2 young 250 mm., 130 g., for 1 young	212 mm., 94 g., for 1 young 264 mm., 155 g., for 1 young	28 mm., 27 g., av. 2 young 62 mm., 72 g., for 1 young	25 mm., 34 g., for 1 young 77 mm., 95 g., for 1 young
1936 #72	June 9 10 days	164 mm., 58 g., av. 2 young 164 mm., 58 g., for 1 young	163 mm., 56 g., av. 2 young 162 mm., 55 g., for 1 young	June 15 June 21	207 mm., 93 g., av. 2 young 254 mm., 132 g., for 1 young	211 mm., 92 g., av. 2 young 250 mm., 128 g., for 1 young	43 mm., 35 g., av. 2 young 90 mm., 74 g., for 1 young	48 mm., 36 g., av. 2 young 88 mm., 73 g., for 1 young
1936 #74 and #75	June 10 14 days	203 mm., 78 g., for 1 young	190 mm., 78 g., for 1 young	June 13	224 mm., 97 g., for 1 young	216 mm., 94 g., for 1 young	21 mm., 14 g., for 1 young	26 mm., 16 g., for 1 young
1936 #89	June 10 15 days	201 mm., 83 g., av. 2 young	207 mm., 86 g., for 1 young	June 15	234 mm., 123 g., av. 2 young	232 mm., 120 g., for 1 young	33 mm., 40 g., av. 2 young	25 mm., 34 g., for 1 young
1936 #99	June 22 15 days	174 mm., 68 g., for 1 young	179 mm., 67 g., av. 2 young	June 25	207 mm., 85 g., for 1 young	200 mm., 83 g., av. 2 young	33 mm., 17 g., for 1 young	21 mm., 16 g., av. 2 young

the wound was healing nicely and the victim's weight was 85% of the average of its litter mates. After 8 days, the leg was healed as a serviceable deformity and the cripple's weight was 71% of the average of its litter mates. Another young maintained its normal growth rate during the healing of a gash in its abdominal wall 20 mm. long and sufficiently deep to penetrate the body cavity; the wound was inflicted when the animal was about 3 days old and it almost completely healed in the space of 5 days. The incisions of properly tagged young were sometimes fairly well healed as early as the third day; usually by the fifth; and almost always by the tenth or twelfth days, even in cases marked by exceptional festering.

Table 4 summarizes all of the comparable data we have on the growth of tagged and untagged litter mates. It may be seen that sometimes the better showing was made by the tagged members; sometimes by the untagged. Considered collectively, the tagged young gained, in 96 growth-days, a total of 676 mm. and 564 g. or an average of 7.0 mm. and 5.88 g. per day; the untagged, in 75 growth-days, 495 mm. and 444 g. or an average of 6.6 mm. and 5.92 g. per day. Likewise, the 12 tagged individuals taken as specimens in November and December, 1936, compared favorably in size and physical condition with 120 other young of the year caught during the State trapping.

A few additional remarks may be made in conclusion. Best results from a general tagging program are assured if the tagging be done in a way least disturbing to adults and young. The relatively small lodges usually constructed in the moderately deep water of marshes are likely to contain the most easily accessible litters. The tops of these small lodges may frequently be lifted up on one side to expose the nests; after tagging, the young may be replaced, tucked in and covered, and the tops of the lodges fitted back approximately as they were originally. An investigator should make all efforts to return young of probable suckling sizes (under 250 mm. in length and 130 g. in weight) to the lodges in which they belong, even though captured from the water outside—for adults may be lax about gathering together scattered members of their families.

We do not feel it advisable to tag the patently unthrifty young that may be found in various litters. These, in our observational areas, are often afflicted with a skin disease and soon die. Advanced cases are marked by underweight, by watery, swollen pustules on ventral surfaces, or by hairlessness about legs, base of tail, and underparts. Incipient cases in individuals of apparently normal size and health may at times be detected by a slight baldness or dandruff-like scurf on head or back, or possibly by one or a few small watery blisters on the tail. Exceptional viciousness on the part of undersized young may—but not necessarily—denote failing health, as may also, of course, unnatural lethargy.

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WINTER FEEDING AT FAVILLE GROVE, 1935–1937

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This paper describes feeding experiments conducted during the winters of 1935–36 and 1936–37 on the Faville Grove Wildlife Area, Jefferson County, Wisconsin. An earlier paper (1) presented the writer's findings for 1935–36, but these are now somewhat modified. Siegler (2) has described rodent damage at Faville Grove, and Leopold (3) quail mortality in Wisconsin during the lethal winter of 1935–36.

Weather Influence

The weather of earlier parts of the year often sets the stage for the winter wildlife drama. The two years under consideration are examples of extreme disparity in both the setting and in the drama itself.

The summer of 1935 was ideal for wildlife. Food of all sorts was plentiful and cover was lush. Nesting was unusually successful and game birds were abundant, but winter brought the deepest snow and most intense cold of the century. As a result the plentiful food supply was buried under several feet of snow, and the birds died.

In the summer of 1936 a record drought severely curtailed both food and cover. The diminished crop of ragweed and acorns suffered a further loss of 10 per cent from insect attack. Nesting results were poor due to the drought. Winter brought no snow and little severe cold, but the fields were sealed by a blanket of ice on January 6 and remained so, without a break, for two months. Few birds died on fed areas like Faville Grove; but on some unfed areas quail and Hungarian partridges perished in large numbers.

In the state as a whole, the survival in 1937 was much better than during the preceding winter. No fed birds froze in 1937 whereas many froze in 1936 (3). Artificial feeding was better organized in 1937. Seeds on stalks stood above the ice of 1937, but were deeply covered by snow in 1936.

The contrast between the two winters at Faville Grove is shown in the following figures:

	1936	*1937*
Winter mortality (composite of all game birds)	50%	10%
Bobwhite mortality	70%	12%
Pounds of grain consumed at 30 stations, serving 2,300 acres	3700	2250

The main objectives of this study were to measure the amounts of artificially fed grains consumed by the species using the feeding stations, and to compare the palatability of various grains.

To know what foods are palatable is important for reasons other than coddling birds. Palatable foods have high holding power and presumably high sustenance value, but are quickly consumed. Unpalatable foods have low holding power, may have sufficient sustenance value, and last longer. An economical and sufficient feeding program must present combinations of foods that fit these properties to the local needs.

It should also be understood that the object of all feeding is to supplement, not to replace, wild foods and crop residues. No one food, even corn (8), is a complete ration.

MEASURING CONSUMPTION

So far as conditions permitted consumption was measured by weighing the food used per unit of time by known populations of a single species at isolated stations. Neither complete isolation nor pure populations were ever attained.

Foods were presented (1) in piles on the ground or on window screens, (2) in trays or troughs, (3) in self-feeding hoppers, and (4) as corn ears impaled on spikes. In the case of the first three methods the food was under a shelter. Whole ears were fed in the open on horizontal pole racks elevated 3–4 feet above the ground; upright spikes were driven through the poles for impaling the ears.

MEASURING PALATABILITY

Palatability was measured by comparing the consumption from equal amounts of various foods simultaneously offered side-by-side, usually in compartmented troughs or hoppers. No attempt was made to measure the feeding population, but an attempt was made to deal with each species separately. Pilfering rodents were never eliminated from bird experiments, but birds were easily excluded from rabbit experiments by feeding at night.

Each series of foods tested for palatability was measured against yellow dent corn as a standard. The index to palatability is the percentage of each food consumed (by weight or bulk) at the time the corn is gone. The order of placement of foods in the feeding tray or hopper was frequently shifted to eliminate effects due to fixed positions. In 1936 the corn was often gone before the other foods were measured. In 1937 a special effort was made to measure them just at the time the corn became exhausted. This should give greater accuracy to the 1937 ratings.

OBSTACLES TO MEASUREMENT

The measurements here presented are those selected as probably having the least error. Results of the bulk of the experiments were discarded as inaccurate. Each method of feeding presented its own obstacles.

Loose grain, even under shelters, was often snowed under in 1936 and iced over in 1937, and the difficulty of estimating its amount was aggravated in both cases by the inevitable scattering. The point of complete consumption is impossible to determine when scattered grain is imbedded in frozen ground or snow. Scattering was lessened somewhat by feeding loose grain on a window screen.

Rodent pilfering of loose grain (especially the dehearting of corn) was severe.

Ear corn piled under a shelter was not covered over as readily as shelled grain, but loose ears cannot be used in squirrel territory because squirrels carry them away, sometimes to a distance of a half-mile (1).

Self-feeding hoppers with from 1 to 8 compartments, and troughs which had from 1 to 15 compartments were tried, but both had the fault of clogging up during snow and ice storms. Where mixtures of corn and some less palatable grain were used, rodents often scratched out all the mixture to get the corn. Coverings of wire mesh lessened scratching, but caused birds to "shy off" for a time, and made the trays difficult to clean when ice formed in them.

Prairie chickens presented a special problem, because they would not enter shelters to feed from hoppers or troughs (as they readily do in central Wisconsin). Hence their preferences could not be determined, but their consumption of ear corn, which they readily ate from trees to those on crowded trees. Siegler (2) found that rodents damaged certain shrubs while ignoring other equally available plants of the same species. Mitchell and Hosley (5) applied fertilizer and thus changed the palatability of dogwood to deer. Stoddard (unpublished) thinks that the palatability of a grain may vary with the time of cutting. Chemical variation in soil, or perhaps "curing" differences, may have produced the discrepancies later described.

TABLE 1
PALATABILITY TESTS, 1937

Station	Test	Shelled corn	Scratch feed	Buckwheat	Wheat	Barley screenings	Oats	Wheatland milo	Black Amber sorghum	Corn & wheat 1:1	Corn & buckwheat 1:1	Period tested
1	a	1		4		2		3				12/ 8–12/31
	b	1	3	3	3	4		5	5		2	12/31– 1/16
	c		3	4	5	6		8	7	2	1	1/16– 2/15
2	a	1		2		3		2				12/18–12/31
	b	1	3	5	4	6		7	4		2	12/31– 1/23
	c		2	3	6	7		4	5		1	1/23– 2/15
3	a	1	2	5	3	4	7	8	6			12/31– 1/16
	b		1	3	2	4	6	7	5			1/16– 1/26
4	a	1	3	2	7	4	4	5	6			12/30– 1/ 9
	b		2	1	3	7	5	6	4			1/ 9– 1/24
5	a	1	3	2	7	4	4	5	6			12/30– 1/15
	b		2	1	3	7	5	6	4			1/15– 1/24
	c		1	3	2				2			2/15– 2/22
6	a		1	3		4	2	2	5			12/30– 1/ 9
	b		1	5		6	4	3	7		2	1/ 9– 1/13
	c		1	3	2				2			2/15– 2/22

Method of scoring tests: In any given test, the figures indicate the order in which the grains disappeared. A special effort was made to score each test before the corn compartment was empty.

a rack, was measured. The shelled volume of the ears consumed was then computed.

One lot of grain was sometimes taken more readily than another of the same kind. Variations of palatability within a given food have been noted by others. Schmidt (4) found that sharptailed grouse preferred birch buds on isolated

SENSORY MECHANISM OF SELECTION

Do birds select food by sight alone?

Late one evening in the winter the writer set out a trough with 14 grains, two of which were corn. During the night three inches of loose snow covered the trough. In the morning the tracks of a Hungarian partridge led directly to the corn compartments, both of which it had opened. The snow covering the other grains remained undisturbed.

In another instance a pheasant displayed the same apparent detective ability, but in this case there were seven other grains instead of twelve, and the snow was crusted.

RESULTS OF PALATABILITY AND CONSUMPTION TESTS

In the previous report (1) 24 grains and legumes were tested and given a palatability rating. In 1937 eight of the grains commonly used in winter feeding were re-tested. The results appear in Table 1.

Palatability Ratings

Table 1 shows that corn always disappeared first, but that each of its competitors varied in order of consumption as between different tests and stations. For some reason, this variation was greater in 1937 than in 1936. To derive a general order of preference it was necessary to average the tests. This is done in Table 2. These averages for 1937 are also reduced to a percentage basis, and are compared with the ratings for 1936.

The year-old barley used in 1937 ranked lower than when fresh in 1936. but the year-old buckwheat higher. A germination test showed the old barley to be still largely viable. The lower rank of wheat and milo in 1937 may be due to inferior quality.

TABLE 2

PALATABILITY RATINGS OF EIGHT GRAINS, 1937

Grain	Times tested	Points	Av. points per trial	100% basis	Postion rated in 1936
1. Corn	7	28	4.0	100	1
2. Scratch feed	14	42	3.0	75	2
3. Buckwheat	16	16	1.0	25	4
4. Wheat	12	7	.6	15	3
5. Oats	8	− 1	−.1	− 2	7
6. Amber sorghum	14	− 7	−.5	−12	8
7. Wheatland milo	14	−12	−.8	−20	6
8. Barley	14	−13	−.9	−22	5

Method of averaging tests: First, second, third, and fourth places in a test were given 4, 3, 2, and 1 points. Grains showing very low or inappreciable consumption were given minus ratings down to minus 4. The scores made by each competitor were then added (Column 2) and divided by the number of tests (Column 1) to get the average (Column 3). This average was then converted to a percentage basis, using corn as 100%. A minus score means decidedly inferior palatability.

The results summarized in Table 2 do not confirm the conclusion drawn by Stoddard that birds are slow to learn to eat unfamiliar seeds. Neither buckwheat, wheat, nor milo are grown in this region, yet the first two were taken readily.

Palatability to Various Game Birds

Because the diets of quail, Hungarian partridge, pheasant, and prairie chicken differ, one might assume that their tastes for cultivated grains would also differ. Our tests revealed no marked difference, however, in the palatability of the 8 grains supplied to these 4 game birds. The ratings, therefore, apply to all (except that prairie chickens, for the reasons already mentioned, ate only ear corn).

Moore (7) found that in a series of food patches used by both pheasants

and quail, soybeans were utilized by quail more than by pheasants. In the present investigation four acres of standing Manchu soybeans were used slightly by quail and pheasants (a little more by the latter) but not at all by Hungarian partridges. All of these birds avoided two patches of baby lima beans which had been left in the field.

Rabbit Tests

Cottontail rabbits seem to relish the grains tested in about the same order as do the game birds. Table 3 shows the consumption at four stations used only by rabbits. Equal trays of corn, buckwheat, and corn-buckwheat mixture were presented simultaneoulsy, and also similar offerings of corn and wheat. In each case the residues of the mixtures were sorted out to determine consumption of their constituents (last two columns).

TABLE 3

RABBIT PALATABILITY: CORN VS. SMALL GRAINS

Trial	Pure corn	Pure small grain	Mixture before separating	Separated mixture	
				Corn	Small grain
Corn vs. buckwheat	92%	4%	53%	89%	18%
Corn vs. wheat	100%	49%	74%	100%	49%

The apparent liking of the rabbits for wheat was probably due to the exhaustion of the corn in the wheat trial, but not in the buckwheat trial. Later evidence indicated that rabbits had little preference between wheat and buckwheat.

The rabbit consumption estimate for 1936 (1 pound per week) was based on an imperfect census. In 1937, a backyard station used exclusively by two rabbits was supplied on successive nights with corn alone, corn plus a series of other foods, and other foods alone, each item being weighed before and after exposure. The results (Table 4) represent a combination palatability and consumption test.

TABLE 4

NIGHTLY CONSUMPTION BY TWO RABBITS

Corn alone, grams (average of 12 nights)		Total, grams
171 corn		171
Corn plus other foods		
170 corn	5 black soybean,[1] 0 white soybean[2]	175
123 corn	30 black soybean	153
107 corn	14 white soybean	121
Other foods alone		
x	4 black soybean, 3 white soybean	7
x	60 rolled oats, 57 sorghum[3]	117
x	153 scratch feed	153
x	27 rye	27
Average per night, 2 rabbits		158
Average per night per rabbit		79

[1] Early Wisconsin black soybeans.
[2] Manchu soybeans.
[3] Black amber sorghum.

Last year's estimate of one pound per week per rabbit would imply consumption at the rate of 64 grams per night. This year's results as shown in Table 4, show the eating of 79 grams, an indication that the pound per week estimate is a little low.

Consumption by Game Birds

The consumption rates obtained in 1936 were doubtless high due to snowing under of natural foods. Ice invalidated attempts to revise them in 1937. The 1936 rates are therefore repeated in Table 5.

An indirect check on the pheasant consumption figure (2 pounds per week) may be made as follows: Gig-

stead (6) says a pheasant crop full of corn weighs up to 2.2 ounces (61 grams) wet. The four heaviest crops examined by Moore (7) weighed from 50 to 57 grams dry. From these figures it seems justifiable to assume two fillings daily of 50 grams dry weight, a rate which would bring the weekly consumption to 700 grams or 1.6 pounds. This would indicate that a pheasant consumes 2 pounds per week from feeding stations only when natural foods are extremely scarce.

COMPUTING THE FOOD BUDGET

On an area previously fed, the consumption per station can be used to predict needs. Of the 30 stations at Faville Grove in 1937

70 per cent showed a consumption of 1 pound per day,
10 per cent showed a consumption of 3 pounds per day, and
20 per cent showed a consumption of 5 pounds per day.

On a new area, the consumption per bird can be multiplied by the census. This is done for Faville Grove in Table 5, using consumption rates rounded to the nearest half-pound. The feeding period may be assumed to be eight weeks.

TABLE 5

USING THE CENSUS TO COMPUTE A FOOD BUDGET

Species	Amount consumed per bird per week (in lbs.)	1936 census	Weekly food budget (in lbs.)	1937 census	Weekly food budget (in lbs.)
Quail	0.5	200	100	70	35
Hungarian partridge	1.0	200	200	140	140
Prairie chicken	1.5	40	60	30	45
Pheasant	2.0	60	120	160	320
Total		500	480	400	540

Faville Grove had 20 per cent fewer game birds in 1937 than in 1936, but the table calls for almost 10 per cent more food; the marked increase in pheasants makes this difference.

The weakness of such a budget is inability to predict the length and severity of the winter, and the consequent duration and rate of food-demand. Actually during the mild winter of 1937, birds depended largely on natural feeds, so instead of eating more grain in 1937, as predicted in the table based on 1936 feedings, they ate only 60 per cent as much.

IS GRIT ESSENTIAL?

No grit was supplied. Most birds found dead during 1936 contained grit, despite the deep snow. Although grit was unobtainable, the birds were able to hold enough of it to get by the critical period.

Again in 1937 there must have been a grit scarcity, for literally every square inch of ground was coated with ice for two months. It was noted that as soon as the tops of hummocks began to thaw out, pheasants eagerly tore them to pieces in search of something, presumably grit.

NOTES ON NATURAL FOODS

Both in 1936 and 1937 we obtained evidence that poison sumac fruits (*Rhus vernix*), a plant confined to tamarack bogs, should be regarded as a staple food for pheasants and quail. Tracks and droppings repeatedly showed that the birds were eating these berries both early and late in the winter, often in competition with corn.

Another food taken with some regularity by pheasants, even with corn

available, was the burdock (Arctium).

Marsh shield fern (*Aspidium cristatum*) was browsed in the tamarack swamp by both rabbits and pheasants.

Heads of bull thistle (*Cirsium lanceolatum*) had been pulled apart by pheasants on several occasions.

Species of dock (Rumex), sticktights (Bidens), lamb's quarters (Chenopodium), and pigweed (Amaranthus) were all taken by pheasants until exhausted, even with corn available.

During late fall, pheasants fed on acorns of the bur-oak (*Quercus macrocarpa*).

ECONOMIZING WITH MIXTURES

Corn has proved its worth as the staple feed, but some years it is expensive. Can cheaper, less palatable grains be substituted without harming the birds? Probably, yes.

Is it economical to dilute corn with some less expensive feed? No, unless the hopper-tray is screened to prevent the mixture being scratched out and wasted in an effort to extract the corn.

Do mixtures, when scratching wastage is eliminated, slow up consumption? Yes, all the grains rated in Table 2 were fed in mixture with corn and the slowing up found to vary roughly in proportion to their palatability in pure form. The least palatable grains, in mixture with an equal volume of corn, reduced consumption as much as 25 per cent.

Mixtures which include screenings are not recommended because of the noxious weed seeds they commonly contain.

PRACTICAL FEEDING METHODS

Many of the limitations experienced in connection with experimental feeding apply also to practical feeding operations. Impaling corn ears on a rack has fewer faults and more advantages than any other method so far tried at Faville Grove.

SUMMARY

1. The winters of 1936 and 1937 provided excellent conditions for the study of artificial feeding, because 1936 was abnormally cold and snowy and 1937 abnormally icy, but not cold.

2. Corn was greatly preferred to any other grain tested. The acceptance ranking of seven other grains in 1937 was: scratch feed, buckwheat, wheat, oats, sorghum, wheatland milo, barley. In 1936 wheat, milo, and barley ranked higher.

3. Rabbits and game birds seem to have about the same tastes for these grains.

4. Consumption per animal per week is: pheasant and squirrel, 2 pounds; prairie chicken and rabbit, 1.5 pounds; Hungarian Partridge, 1 pound; quail, 0.5 pounds.

5. Grit may be unavailable for long periods without causing mortality among game birds.

6. Poison sumac, burdock, sticktights, dock, lamb's quarters, and pigweed are taken even with corn available

7. Mixture of cheaper grains with corn reduces consumption as much as 25 per cent, but the tray must be protected by wire mesh to prevent wastage by scratching.

8. Screenings containing weed seeds are not recommended for feeding.

9. Spiking ears on a rack has fewer faults than other methods of feeding.

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FOOD HABITS OF IOWA SKUNKS IN THE FALL OF 1936[1]

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An investigation of the food habits of the striped skunk (*Mephitis mesomelas avia* (Bangs)) and spotted skunk (*Spilogale interrupta* (Rafinesque)) in Iowa was undertaken by the writer during the fall of 1936 as a part of the studies in the ecology and management of these animals. Between September 15 and December 1 a collection of scats was made chiefly in the vicinity of Ames in Story County, but eight were collected from the vicinity of Eagle Lake and 21 from Garner, both in Hancock County, and 60 at Dewey's Pasture, Clay County, an ungrazed state preserve reverting to prairie, near Ruthven, Iowa.

The scats, 210 in number, were found principally near skunk dens and in pathways along fence rows. The number of spotted skunk scats collected was, six in September, 13 in October, and 40 in November; and of the striped skunk, two in September, 31 in October, and 118 in November.

The research was under the supervision of Dr. George O. Hendrickson, Assistant Professor in Wildlife Management, Iowa State College, and Dr. Logan J. Bennett, Associate Biologist, U. S. Bureau of Biological Survey.

When the analyses were begun the weight method was used, but it was soon abandoned for the quicker, and more satisfactory volumetric system. Hence the frequency indices (Table 1) include records from scats analyzed under both methods, whereas the volumetric indices include only those studied by the volumetric process. Volume analyses were carried on by means of two cylinders, one graduated in cubic centimeters up to 100, and the other in fifths of a cubic centimeter up to 10. To increase accuracy, readings were made of the volume of the various foods under pressure of a glass plunger weighing 177 grams.

In determining the numbers of insects in a scat, counts of the parts highly resistant to digestion were most helpful. The presence of crickets (*Gryllus* spp.), white grubs (*Phyllophaga* spp.), and ground beetles (Carabidae) was indicated by the mandibles. The hind legs were the best proof of grasshopper (*Melanoplus* spp.) occurrence, and the head capsules were practically all that remained of various larvae (Coleoptera, Lepidoptera, and Diptera).

In comparing the proportions of different foods determined by scat analyses it should be remembered that the ratio between the quantities of these remains is not the same as that between the bulks of the original substances before consumption. The analyses are supplemented by the numbers of individuals eaten, however, and these help to make the method indicative and accurate enough for all practical purposes.

[1] Jour. paper No. J480 of the Iowa Agricultural Experiment Station. Project No. 549.

Iowa State College, in cooperation with the U. S. Biological Survey, the American Wildlife Institute, and the Iowa Conservation Commission.

TABLE 1

A SUMMARY OF THE FOODS OF STRIPED AND SPOTTED SKUNKS

	CLASS FREQUENCY INDICES Based on 149 Mephitis and 59 Spilogale Scats		VOLUMETRIC INDICES Based on 143 Mephitis and 49 Spilogale Scats			
	Mephitis	Spilogale	Mephitis	Spilogale	Mephitis	Spilogale
Type of Food	Percentage of identifications	Percentage of identifications	Average volume per containing scat	Average volume per containing scat	Percentage of total food material	Percentage of total food material
Arthropod	92	44	20.06	8.11	64.06	30.78
Mammal	21	47	10.07	7.36	7.36	30.66
Bird	13	27	14.53	8.31	6.37	25.14
Vegetable	56	27	2.3	1.99	4.31	1.59
Inert	91	56	5.69	.67	17.88	11.83

ARTHROPODS

Striped Skunk

Insects were apparently the most important food during the fall months as they comprised 64.06 per cent of the total food remains, 33.02 per cent of the insects being grasshoppers. In fact grasshoppers constituted 21.15 per cent of the total of all food. In 134 scats there were found remains of 1,696 grasshoppers, all except two representing the genus Melanoplus. These two exceptions were Carolina locusts (*Dissosteira carolina*). The smaller species taken, of which *M. femur-rubrum* was the most common, outnumbered the larger grasshopper, *M. differentialis*, approximately three to one. The greatest number of grasshoppers represented in a single scat was 94 of a small species of Melanoplus and next 57 of *M. differentialis*.

White grubs (*Phyllophaga* spp.) were the next most important food item, constituting 30.77 per cent of the arthropod matter and 19.71 per cent of the total food. They appeared in 59 feces with 71 grubs in one scat as the largest number taken at one time. The percentage of grubs is probably above average because of the abundance of these larvae in Dewey's Pasture where many scats were picked up. The scats collected in more highly cultivated areas near Ames had a low percentage of these grubs.

TABLE 2

A COMPARISON OF THE NINE MOST IMPORTANT FOOD ITEMS OF THE STRIPED AND SPOTTED SKUNKS

MEPHITIS		SPILOGALE	
Food item	Percentage of total food material	Food item	Percentage of total food material
Grasshoppers	21.15	Meadow mice	20.54
White grubs	19.71	Blue-winged teal	15.18
Crickets	11.24	White grubs	11.71
Meadow mice	4.18	Grasshoppers	7.94
Chickens	4.16	Crickets	7.42
Ground cherries	2.94	Mallards	4.96
Bee larvae and wax	2.53	Cottontails	4.72
Ground beetles	2.46	Deer mice	2.62
Cottontails	1.37	Red-wings	2.18

The cricket (*Gryllus assimilis*) was the third most important food item, composing 17.52 per cent of the arthropod matter and 11.24 per cent of the total food. There were 1,787 crickets taken by 51 skunks with 164 as the largest number to appear in any one scat.

Ground beetles (Carabidae) ranked second in number of appearances, but in volume made up only 3.85 per cent

of the arthropod matter and 2.46 per cent of the total food. There were remains of 635 carabids found in 62 scats of which 57 of the genus Harpalus was the greatest number to appear in any one scat. Approximately two-thirds of the ground beetles taken belonged to this genus and the rest comprised a variety of the smaller carabids.

Beeswax and the remains of bee larvae appeared seven times and composed all of the scats in which they were contained. They constituted 3.94 per cent of the arthropod matter and 2.53 per cent of the total food. These feces were traced to two skunks that had rifled a bee tree; as a rule the comb of bees probably does not form a prominent part of the skunk's diet.

Other insects found which comprised less than half of one per cent of the arthropod matter were adult May beetles (*Phyllophaga* spp.), weevils (Curculionidae), bumble-bees ((*Bombus* spp.), unidentified larvae, and honey bees (*Apis mellifera*). Several cocoons also were found.

Millepedes numbered 18; in no case did a large number appear, but only a trace in each containing scat. The remains of only one spider were detected.

Insect debris, further unidentified, made up 9.82 per cent of the arthropod matter and 6.29 per cent of the total diet. In this allocation was placed all insect material that was extremely difficult to separate and which if not separated would alter the final results to no appreciable degree.

Spotted Skunk

Insects share first place with mammals in the fall food of the spotted skunk. They were found in 26 per cent of the feces, averaged[2] 8.11 cc. per containing scat, and constituted 30.78 per cent of the total food. White grubs ranked first in bulk among the insects eaten, as was the case with the striped skunk also, due to inclusion of material taken from Dewey's Pasture. Despite the fact that they appeared in only five scats white grubs made up 38.04 per cent of the arthropod matter and 11.71 per cent of the total food. The average was 30.2 grubs per scat containing them with 44 the greatest number in a single scat.

Grasshoppers ranked second in insect food taken with crickets a close third. With 25 appearances the grasshoppers made up 25.79 per cent of the arthropod matter and 7.94 per cent of the total food. The smaller species of Melanoplus appeared 21 times with an average of 2.67 individuals per appearance and the greatest number in a single scat was 38. The larger *M. differentialis* was found in five scats with an average of 7.6 per appearance; 16 was the greatest number in any one scat.

Ground beetles in fourth rank composed 4.32 per cent of the arthropod matter and 1.34 per cent of the total food remains. None were taken in abundance and they appeared in only 13 feces. One scat contained remains of 32 medium-sized carabids.

Unidentified larvae composed 2.45 per cent of the arthropod matter and .75 per cent of the total food. Traces of stink bugs (Pentatomidae) and honey bees also appeared.

Insect debris, further unidentified,

[2] Average volume per containing scat refers to the arithmetic mean of the volumes of a particular food item in the scats in which it appeared.

made up 5.09 per cent of the arthropod matter and 1.57 per cent of the total food volume.

MAMMALS

Striped Skunk

Mammals ranked second in importance among the classes of food, but constituted only 7.36 per cent of the total dietary remnants. They appeared in 21 per cent of the feces with an average volume of 10.07 cc. per containing scat.

Meadow mice (*Microtus* spp.) comprised 56.8 per cent of the mammals and 4.18 per cent of the total volume of food. They appeared in 16 scats and 3 mice was the largest number represented in a single scat.

Cottontail (*Sylvilagus floridanus mearnsi*) fur, found in seven scats, made up 18.54 per cent of the mammal matter and 1.37 per cent of the total volume of food remnants.

Muskrat (*Ondatra zibethica*) fur was found in three scats but constituted only .73 per cent of the total food bulk. One shrew (*Sorex* sp.), one deer mouse (*Peromyscus* sp.), and one striped ground squirrel (*Citellus tridecemlineatus*) had also been taken. Skunk (*Mephitis mesomelas avia*) fur and bones were found in one scat.

Spotted Skunk

Mammals appeared in 47 per cent of the scats with an average volume per containing scat of 7.36 cc. Mammals composed 30.66 per cent of the total volume of food.

Meadow mice, appearing in 14 scats, made up 66.99 per cent of the mammal matter and 20.54 per cent of the total food remains.

Cottontail fur, appearing in three scats, composed 15.4 per cent of the mammal matter and 4.72 per cent of the total dietary remnants.

Deer mouse remains, found in three feces, comprised 8.54 per cent of the mammal matter and 2.62 per cent of the total food remnants.

Fox squirrel (*Sciurus niger rufiventer*) fur and mole (*Scalopus* spp.) remains each appeared in three scats. The former item was 5.18 per cent of the total mammal matter and 1.59 per cent of the total food, and the latter 3.24 per cent of the mammal matter and .99 per cent of the total food remnants.

Skunk (*Spilogale interrupta*) fur and long pig bristles with pieces of pig bone each appeared in one scat.

BIRDS

Striped Skunk

Of the bird remains comprising only 6.37 per cent of the total food those of chickens predominated. Birds appeared in 13 per cent of the scats with an average volume of 14.53 cc. per containing scat. It was impossible to determine whether the chicken remains were carrion or fresh kills but it is highly probable that they were the former because on numerous occasions the writer found dead chickens in fields where they had been scattered with barnyard manure. Chicken remains appeared 10 times and composed 65.2 per cent of the bird, and 4.16 per cent of the total, food remnants. The average volume of the chicken remains was 18.94 cc. per containing scat.

In the case of all of the other birds eaten each bird made up less than 1 per cent of the total dietary remnants. The following were identified: Eastern Tree

Sparrow (*Spizella arborea arborea*), one; English Sparrow (*Passer domesticus domesticus*), one; Mallard (*Anas platyrhynchos platyrhynchos*), one; Bronzed Grackle (*Quiscalus quiscula aeneus*), one; Northern Flicker (*Colapter auratus luteus*), one; Red-wing (*Agelaius phoeniceus*), one; there were also remains of three unrecognized birds.

Spotted Skunk

Bird remains appeared in 16 scats or 27 per cent of the total, their average volume was 8.31 cc. per containing scat, and they comprised 25.14 per cent of the total food matter. Blue-winged teal made up the largest part with 60.47 per cent of all bird remains and 15.18 per cent of the total food. This percentage is due to the appearance of teal in nine scats from the den of a skunk near Eagle Lake. It is quite improbable that a skunk could catch a live duck on or near a lake, but since at the time of collection of the scats the hunting season had been open for 15 days, it is likely that the skunk fed upon a dead or crippled duck.

Mallard feathers found in three scats, formed 19.73 per cent of the bird matter and 4.96 per cent of the total dietary remnants. These scats were collected at Dewey's Pasture on the opening day of the duck season. They were also all traced definitely to one skunk, which may have found a dead duck and made several meals from it.

Other birds eaten were: Eastern Robin (*Turdus migratorius migratorius*), one; Red-wing, one; Eastern Tree Sparrow, one; and unidentified bird, one.

VEGETABLE MATTER

Striped Skunk

Vegetable matter appeared in 56 per cent of the scats but composed only 4.31 per cent of the total volume of food. This result differs markedly from that obtained in analyses by Hamilton (1936) who found fruit to be the most important food in New York State, and by Dearborn (1932) who found fruit to rank second in importance, next to insects, in the skunk's fall food in the state of Michigan. Fruit-bearing vegetation in Iowa is not nearly as plentiful as in the states mentioned above and fruit, therefore, is not so readily available a food for skunks.

Ground cherries (*Physalis heterophylla*) ranked second to grass in the number of occurrences with 23, but in volume were first, composing 68.19 per cent of the vegetable matter eaten and 2.94 per cent of the total food.

Although grasses (Gramineae) appeared 75 times and made up 20.45 per cent of the vegetable matter, they were in such minute quantities that they composed only .88 per cent of the total dietary remnants.

Redhaws (*Crataegus* spp.) appeared three times to constitute 6.44 per cent of the vegetable matter, but only .28 per cent of the total food remains.

Other forms of vegetation represented in very small quantities and number of appearances were: oat kernels (*Avena sativa*), eight; horsenettle berries (*Solanum carolinense*), two; barnyard grass seeds (*Echinochloa crus-galli*), two; muskmelon seed (*Cucumis melo*), one; and unidentified seed, one.

Spotted Skunk

Vegetable matter appeared 16 times and made up .159 per cent of the total food, even less than for the striped skunk.

Grass leaves were noted 13 times, and found to comprise 35 per cent of the total vegetable matter and .56 per cent of all the food remnants. They were followed closely by wheat kernels (*Triticum vulgare*), which made up 25 per cent of the total vegetable matter and .4 per cent of the total food remains. Horsenettle berries were third with two records and constituted 16.25 per cent of the vegetable matter and .26 per cent of the total food.

Other forms of vegetation identified, and the number of occurrences were: oat kernel, one; acorn (*Quercus* sp.), one; apple seed (*Pyrus malus*), one; corn kernels (*Zea mays*), two.

INERT MATTER

Inert matter was composed of sand, dirt, and any material too finely ground to be recognized as organic. In the striped skunk's food the inert matter constituted 17.88 per cent of the total, while in the spotted skunk's food it comprised 11.83 per cent of the total bulk of the scats. It appeared in 91 per cent of the striped skunk's scats and in 56 per cent of those of the spotted skunk. When white grubs were consumed the inert matter was very high; when adult insects were eaten it was still high, but when mammals were the source of food there was none present.

SUMMARY

The fall food habits of the striped and spotted skunks differ considerably. Data shown in Tables 1 and 2 indicate that the striped skunk was the greater insect feeder of the two; in fact it ate twice as many insects. Of the separable arthropod remains grasshoppers, crickets, and white grubs constituted 52 per cent of the total food of Mephitis, but only 27 per cent of that of Spilogale.

According to the bulk percentage of mammal remains in the scats the spotted skunk ate four times as much of this class of food as the striped skunk. In both cases meadow mice made up the majority of the mammals eaten; 56.8 per cent in the striped skunk and 66.99 per cent in the spotted skunk. In bulk percentages the spotted skunk ate about five times as many meadow mice as did the striped skunk. The spotted skunk ate cottontails to the extent of 5 per cent of the total food remains; the striped skunk only 1.37 per cent.

Bird consumption by skunks is the usual grounds for characterizing the animals as undesirable by the layman, whose chance observation of a destructive skunk has resulted in the conclusion that all skunks are detrimental. In fact the data given in Table 1 on first sight may seem to support that idea, but due consideration must be given to modifying factors. The spotted skunk is shown to have taken approximately four times as much bird matter as the striped skunk, namely to the extent of 25 per cent of its food. The main items, concerned, however, blue-winged teal and mallard, were all consumed by two skunks, which probably ate the ducks as carrion, thus in reality conferring a benefit by serving as scavengers. Of the 6.37 per cent bird

matter eaten by the striped skunk, 4.16 per cent was chicken remains also believed to have been carrion.

Vegetable matter was eaten to a greater extent by the striped skunk than by the spotted, but in both cases the amount was less than 5 per cent of the total food remains.

There is some indication that the skunk's choice of food is governed to a certain extent by food availability. On Dewey's Pasture in northwestern Iowa white grubs and meadow mice were very abundant and constituted practically all of the food of the skunks there.

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GOOSE NESTING STUDIES ON BEAR RIVER MIGRATORY WATERFOWL REFUGE

Cecil S. Williams and William H. Marshall

The Canada Goose (*Branta canadensis*) has the distinction of being generally regarded as the "king of waterfowl." It has contributed much in the way of economic, aesthetic, and recreational values to our civilization.

Its modern breeding range has been so out-of-the-way, however, that the species has received little attention, particularly with respect to the ecological and physiological factors which influence it during the nesting season.

During April and May of 1937 the writers had an exceptional opportunity to observe the birds, and undertook an intensive study of goose nesting on Unit II (See map, Fig. 1), of the Bear River Migratory Waterfowl Refuge in Utah.

Appreciation is expressed to Refuge Superintendent V. T. Wilson, of the Division of Migratory Waterfowl, U. S. Biological Survey, for the use of a small boat and motor, which facilitated the study. Mr. William Cawley, a CCC enrollee, was a capable and diligent assistant during the latter part of the study.

Area Studied

The nesting of Canada geese on the Bear River Marshes has apparently increased since Dr. Alexander Wetmore's investigations,[1] of about twenty years ago. In the comparatively restricted study area nearly as many nesting geese were found as Wetmore estimated for the whole marsh, which included sloughs and small lakes from Corinne to Willard Spur and North Bay (Fig. 1). Despite this apparent increase of the birds on Unit II, there is no reason for assuming that all other portions of the refuge have been favored with similar increases. Natural changes of water courses and of vegetation, and the artificial impounding of water to form shallow lakes subsequent to the establishment of the Bear River Refuge have tended to make Unit II one of the most important nesting areas, not only for geese, but also for other waterfowl.

Plate 6-A presents a cover type map of Unit II, an area which totals about 5,000 acres, 3,000 being open water varying in depth from a trace to thirty inches. The open water forms a large lake that supports a dense growth of sago pondweed (*Potamogeton pectinatus*). Two other pondweeds, *Potamogeton pusillus* and *P. filiformis* occur less commonly. In the shallower, more protected, arms of the lake, such important waterfowl foods as horned pondweed (*Zanichellia palustris*), wigeongrass (*Ruppia maritima*), and muskgrass (Chara) are prominent. Aside from muskgrass the most common macroscopic algae are Oscillatoria, Cladophora, and Oedogonium. The aquatic animal life of the open water area is dominated by carp (Cyprinus), and chub (Semotilus), while threadworms (Nematoda) and midge larvae (Chironomidae) are numerous in the bottom muck. Water near emergent vegetation

[1] Wetmore, Alexander. Wild ducks and Duck Foods of the Bear River Marshes, Utah, U. S. D. A. Bull. 936, 1921, pp. 3 and 5.

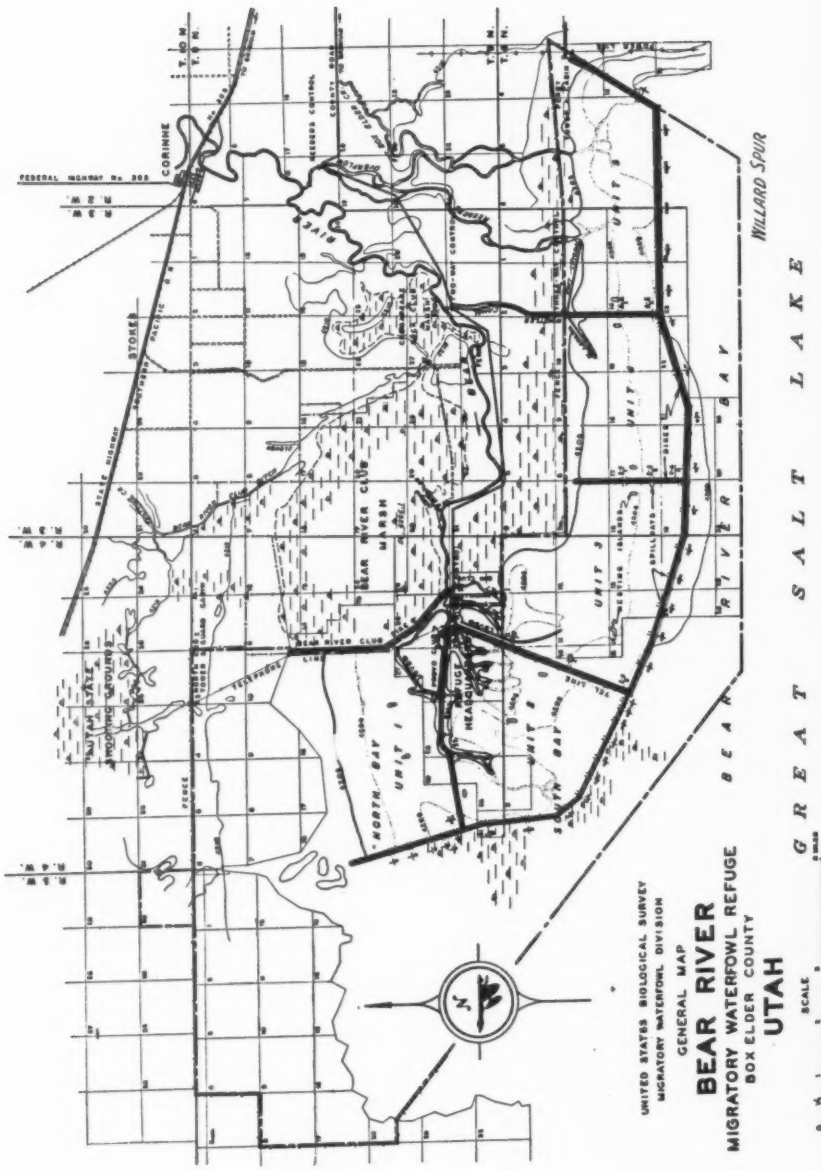

Fig. 1. Map of the Bear River marshes showing the relation of the study area, Unit II, to the several other units of the Bear River Migratory Bird Refuge and to adjacent marsh areas.

Fig. 1. Map of the Bear River marshes showing the relation of the study area, Unit II, to the several other units of the Bear River Migratory Bird Refuge and to adjacent marsh areas.

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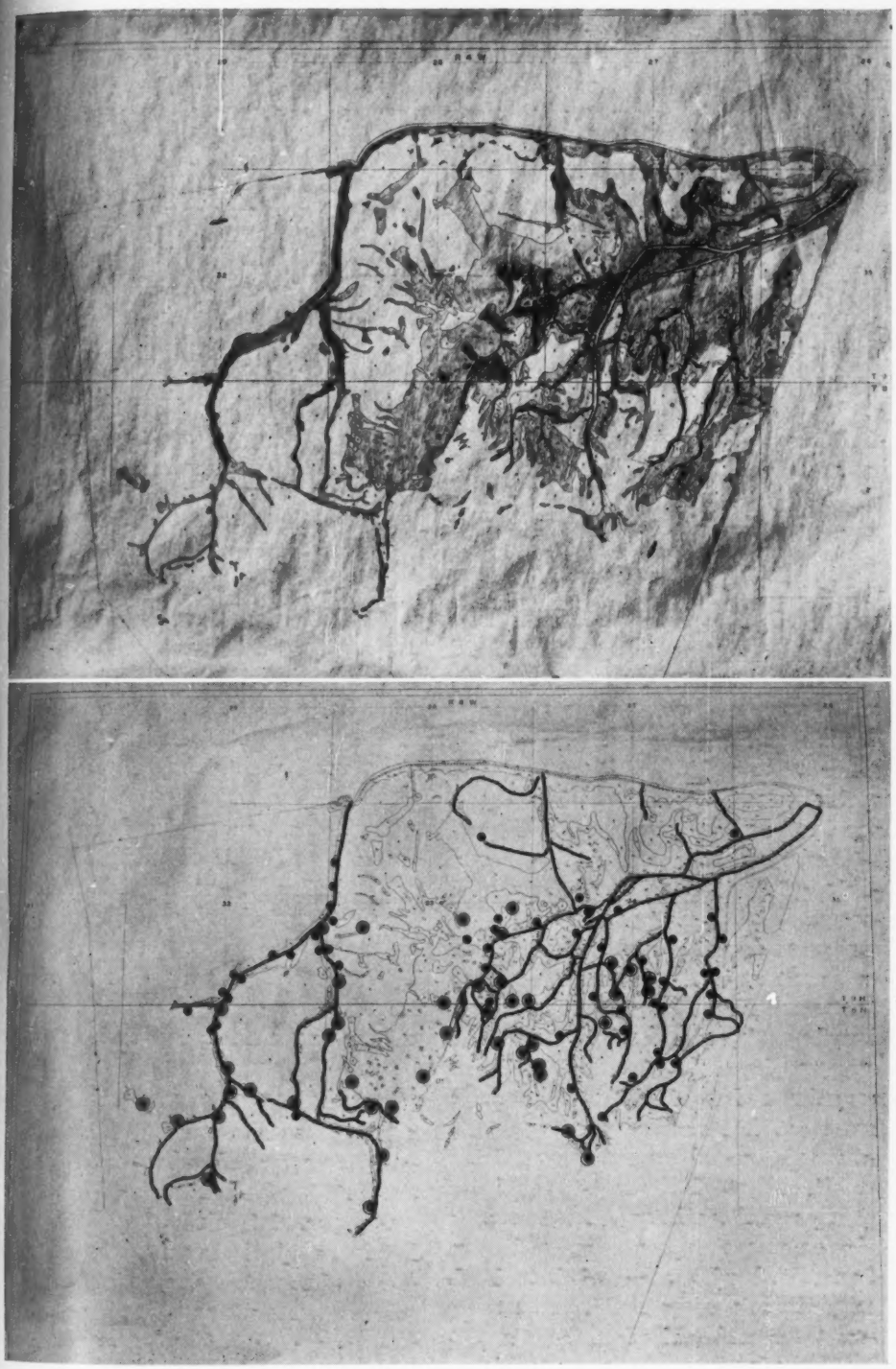

A. (*Upper*)—A cover type map of Unit II, Bear River Refuge. Clear areas, if enclosed, represent barren flats; if not enclosed, open water. Lighter shading shows areas of alkali bulrush and the darker, hardstem bulrush and cattail.

B. (*Lower*)—Nest-channel relationships. Channels are shown by heavy lines; nests are represented by dots; and nests on muskrat houses are encircled. Few nests are located far from channels.

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offers ideal places for the abundant damsel-flies (Zygoptera), dragonflies (Anisoptera), and mosquitoes (Culicidae) to develop. In other habitats backswimmers (Notonectidae) and waterboatmen (Corixidae) as well as other Hemiptera abound. Several species of snails are found in protected places.

Ninety-five per cent of the 2,000 acres of Unit II (not open water) is occupied by well-defined vegetative cover types: saltgrass (*Distichlis spicata*), cattails (*Typha* spp.), hardstem bulrush (*Scirpus acutus*), and alkali bulrush (*Scirpus paludosus*). Communities of plants such as *Hordeum jubatum*, *Juncus balticus*, *Salix* spp., *Eleocharis palustris*, *Xanthium speciosum*, *Atriplex* spp., and *Asclepias speciosa*, are present, and there are also some barren areas and artificial embankments. Figure 2 indicates the relative amounts of each of the major cover types.

It is interesting to note that the course of channels, old and new, influences both the character and distribution of the vegetation. This is especially apparent in the case of hardstem bulrush, and of cattail. Saltgrass makes its best growth on low natural banks, built up by deposition along channels that are periodically flooded and drained. Where water remains in depressions and ultimately evaporates, the areas are barren of vegetation except for glasswort (*Salicornia rubra*) sprouts bordering the receding water edges. Alkali bulrush, the most abundant marsh plant of the unit, adjusts itself to a wide variety of conditions; it grows best in shallow water but occurs also on merely damp earth, as well as in water more than a foot deep.

METHODS OF STUDY

Using the cover map (Plate 6-A) as a guide, the area was methodically searched for goose nests. As the vegetation of the year had not attained sufficient growth by May 15 to hide

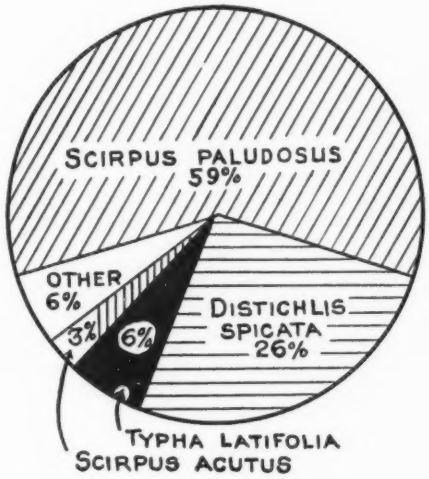

Fig. 2. Percentages of cover types.

nests, it was found possible to survey a great deal of the area by cruising the numerous channels in a small boat. In this manner an observer standing up in the boat could often see a goose on a nest 200 yards away. In addition, the entire unit was inspected on foot during May. The activities of the geese themselves often drew attention to the location of a nest. Thus, pairs usually loitered not far from their nests, and individuals were reluctant to leave the vicinity of nests upon which their mates covered eggs.

Nests were numbered and their location entered on a field map, and later these notes were transferred to a master map. The following sample form was filled out at the time of finding a

Species: Canada goose
Form No. 170
Date: May 13, 1937
Observer: Wm. Cawley
Location: Typha spur
Plot No.

Cover type: Typha
Nesting material: Typha

Height/mud: 24"
Dist.—open water: 2 steps
Dist.—channel: on channel.

Visit No.	Date	Fl. Dist. (steps)	Eggs/H_2O (inches)	No. of Eggs	Down (check)	Remarks
1	5/13/37	30	20	5	✓	On old rathouse
2	5/27/37	20	20	5	✓	
3	6/13/37	—	—	—		Hatched
4						
5						
etc.						

Date concluded: June 13, 1937. No. hatched: 5.

No. destroyed	Predator	Infertile	Flooded	Deserted	Other causes

Special comments: None.

nest, and added to on the occasion of each visit.

In order to minimize chances of predation, the eggs were covered with down or other nesting materials as soon as possible after reaching the nest and recording the number of eggs. Clutches were recorded as hatched only if adequate evidence in the form of egg remains was present. In the case of missing eggs or of empty nests with no sign of hatching, the entry was made as "destroyed—cause unknown." When evidence of a predator was apparent it was noted. Eggs left in the nest after others of the clutch had hatched were considered infertile. Nests in which none of the eggs had hatched and from which no bird was flushed on subsequent visits were regarded as deserted. It is possible that some of the deserted eggs were infertile, and that desertion was due to infertility. It should be stated that due to inclement weather conditions during April and May, search for, and observation on, nests were often inadvisable. The average number of visits per nest was 2.4.

NESTING PERIOD

In 1937 Canada geese began nesting on the Bear River Refuge by the first week in April, the earliest nest being observed on the study area on April 3. By the middle of the month the greater number of the birds had selected their nesting sites and many were incubating. By May 7 all but two of the ninety-five nests on which this study is based had been found; and at that time, twenty-two of the clutches were known to have hatched. The first observation of hatch was made on May 3. The nesting period was considered closed for the geese under observation by June 3, that date being the one on which the last clutch was recorded as hatched.

OBSERVATIONS ON THE NESTING BIRDS

This study was primarily planned to yield ecological data of significance for future management. No attempt was made, therefore, to gather complete information on the nesting behavior of the birds. Certain interesting facts were, however, observed. During the early part of the study, until about the

middle of April, both sexes frequently remained away from the nest for long periods during the day. Later, the pairs seemed loath to leave the vicinity of their nests except during the morning and evening, at which times they often concentrated in small groups to feed. Early in the season, many of the goose droppings contained old seeds and shreds of saltgrass and alkali bulrush; but when the first shoots of wigeon-grass appeared the birds fed upon them.

LOCATION OF NESTS

In general, nests were located toward the lower parts of the marshy area. Only three nests were within one mile of the entrance of the Bear River into the Unit. This grouping of the nests is thought to be of significance in relation to cover type, open water, and channel influences, which are discussed later.

TABLE OF FINDINGS

A summary of all the observations, excepting those pertaining to flushing distances, is presented in Table 1. The upper row of figures for each cover type indicates the number of observations and the lower row the percentage each of these summations composes of its group. It will be noted that for the ninety-five nests found, observations were completed on eighty-four. Two of the eleven nests for which the records are incomplete could not be relocated; seven were found after they had hatched; and two, after they had been destroyed.

FLUSHING DISTANCES

Data relating to flushing distances indicate that the Canada goose is a rather wary bird even when nesting. Of 39 flushings on four selected days in April, the average distance was twenty-five steps or roughly fifty feet; while nearly a month later, the average distance of 37 flushings in four days had dropped to sixteen steps, or thirty-two feet. It is interesting to note that only once in 116 recorded flushings did the bird sneak off the nest and take flight at some distance.

Theoretically it would have been possible to locate 97% of the nests by traversing the area at thirty-foot intervals. In actual practice, however, good visibility, particularly before new vegetation attained its full growth, enabled the observers to survey strips several times that wide. On the basis of these considerations and of the methods used, it is thought that at least 95% of the goose nests in the study area were discovered.

ECOLOGICAL FACTORS INFLUENCING NESTING

Undoubtedly there are many factors which influence the location of nests. On the Bear River marshes the most important seem to be vegetative types, muskrats, and water relationships. Each of these possesses certain properties which add to or detract from the suitability of prospective nesting locations.

Figure 3 indicates the relative values of the main cover types by showing the percentage of the total number of nests found in each. Particularly striking is the fact that 30% of the nests were located in 3% of the area—that occupied by hardstem bulrush. Cattail ranks second in cover attractiveness with 6% of the acreage but 21% of the nests. Saltgrass, covering 26% of the area har-

TABLE 1

SUMMARY OF FIELD OBSERVATIONS

Covertype Acreage Percentage	Number of Nests	Number on muskrat lodges	Distance to channel (steps)				Distance to open water (steps)				Height above mud (inches)				Average clutch	Total number of eggs	Hatched	Infertile	Deserted	Destroyed by predators	Flooded	Failed from other causes	Records completed
			0–5	6–15	16–50	50 plus	0–5	6–15	16–50	50 plus	0–3	4–8	9–12	13 plus									
Scirpus paludosus 1818 (59)	19	13	8	1	5	5	8	4	4	3	3	3	3	10	4.4	71	50	1	3	12	4	1	16
	(20)	(68)	(42)	(5)	(26)	(26)	(42)	(21)	(21)	(16)	(16)	(16)	(16)	(50)		(17)	(70)						
Distichlis spicata 798 (26)	24	0	4	10	9	1	7	13	4	0	17	6	1	0	5.5	112	98	9	4	1	0	0	20
	(25)	(0)	(16)	(42)	(37)	(4)	(29)	(54)	(17)	(0)	(71)	(25)	(4)	(0)		(27)	(87)						
Typha spp. 189 (6)	21	15	8	4	3	6	13	4	2	2	2	2	2	15	5.0	95	74	6	5	1	0	9	19
	(21)	(72)	(38)	(19)	(14)	(28)	(62)	(19)	(10)	(10)	(10)	(10)	(10)	(71)		(23)	(77)						
Scirpus acutus 97 (3)	27	9	13	8	3	3	12	8	4	3	6	7	6	8	4.4	111	88	10	4	4	5	0	25
	(30)	(33)	(48)	(30)	(11)	(11)	(45)	(30)	(15)	(11)	(22)	(26)	(22)	(30)		(27)	(79)						
Artificial banks	4	0	2	2	0	0	2	2	0	0	4	0	0	0	5.2	21	21	0	0	0	0	0	4
	(4)	(0)	(50)	(50)	(0)	(0)	(50)	(50)	(0)	(0)	(100)	(0)	(0)	(0)		(5)	(100)						
TOTALS	95 (100)	37 (39)	35 (37)	25 (26)	20 (21)	15 (16)	42 (44)	31 (33)	14 (15)	8 (8)	32 (34)	18 (19)	12 (13)	33 (35)	4.8	410 (99)	331 (81)	26 (6)	16 (4)	18 (4)	9 (2)	10 (2)	84

bored 25% of the nests. In contrast the 59% of the area grown to alkali bulrush contained only 20% of the nests. Unquestionably alkali bulrush provides the least attractive cover of all here available to nesting geese.

The properties of cover types as affecting goose nesting are obscured by the complex interrelations of other environmental factors. The function of cover in the nesting of the geese cannot definitely be assigned to such purposes as escape, protection, or concealment. Escape invariably occurs by means of flight to open water. Even after the young are out open water is resorted to for safety. It is thought that the advantage of ready vision over surrounding areas influences the choice of nesting sites. Concealment is apparently unimportant since most of the eggs are being incubated by the time concealing vegetation arrives. Shade is decidedly not an important consideration, for in the absence of a brooding bird the nests are always open to the sun's rays no matter in what kind of cover they may be placed.

The Nest Base

Field experience and analysis of the observation records point to the fact that an adequate supporting base for nest building is perhaps the deciding factor in influencing choice of site. The illustrations in Plate 7 indicate how hardstem bulrush, with its tendency toward the formation of dense mats, and saltgrass, with its short but dense growth, fulfill this need for nest building. The photographs reproduced in Plate 8 show that alkali bulrush apparently must be supplemented by a firm base such as is provided by a muskrat house in order to be suitable for nesting. Cattail seems to be similarly deficient. Figure 4, to be discussed more fully later, further illustrates this point.

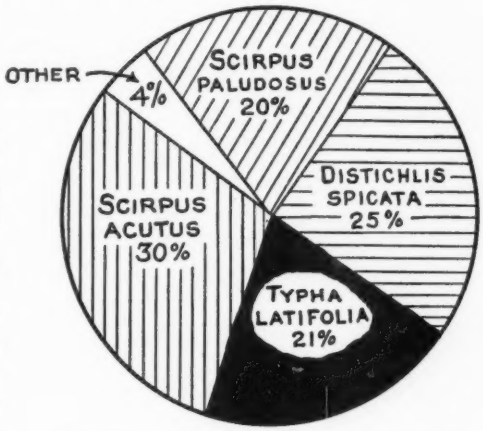

Fig. 3. Percentages of nests found in the different types of cover.

Muskrat Lodges in Relation to Goose Nesting

Because of the requirement of a substantial base for goose nests, the number of muskrat structures on the marsh is important. The lodges and feeding stations of this fur-bearer are scattered quite commonly through the lower reaches of the Refuge. In the unit under observation it was estimated that there were 275 of these potential nesting sites. The area had been trapped during 1936–37, a total of 1,589 muskrats being taken, and it is estimated that muskrats somewhat in excess of that number could be taken annually without detriment to goose nesting.

The relationship between muskrat houses and goose nests is illustrated in Figure 4 and Plate 6-B. It is evident from Figure 4 that without such structures in alkali bulrush and cattail the

nesting population in these vegetative types would be reduced considerably, as 68% of the nests in alkali bulrush and 72% of those in cattail were on muskrat houses. If the nests on muskrat houses in all cover types were elim-

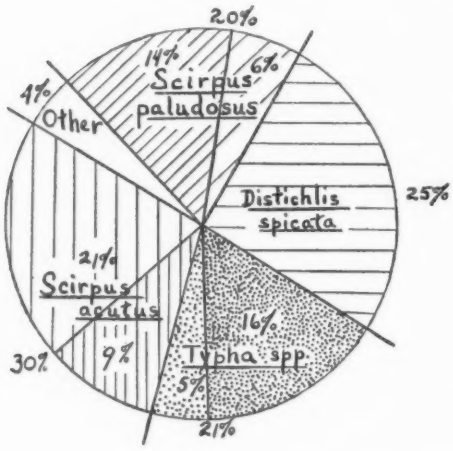

Fig. 4. Relationship between the percentages of Canada goose nests found on muskrat houses (darker portions) and at other locations (lighter portions) in each vegetative cover type. Areas of *Distichlis spicata* and "Other" range (which includes artificial banks and barren places) have no muskrat houses; 68% of the nests found in growths of *Scirpus paludosus* were on muskrat houses; 72% in *Typha spp.;* and 33% in *Scirpus acutus.*

inated the reduction would amount to 39%, or in terms of eggs at the rate of 4.8 to a clutch, to a total of one hundred and seventy-eight eggs. Attention is called to Plate 6-B, where it is shown by symbols that nearly all of the nests in the lower marshes were on muskrat houses. It is safe to estimate that at least 80% of all the nests were dependent on muskrat activities of previous years.

NEARNESS OF WATER

A pronounced relationship, as indicated in Plate 6-B, was found to exist between the locations of nesting sites and nearness to channels or open water. Of the total of 95 nests only 16% and 8%, respectively, were beyond 50 feet from channels or open water, while 63% and 77%, respectively, were within 30 feet.

It is rather difficult to evaluate the real significance of nearness to water and channels, as compared with that of the character of cover types, and the availability of muskrat houses for foundations, because of the complex interrelations of environmental factors in general. When it is considered, however, that the distribution of open water and channels determines the character of most of the vegetation, and has a marked influence on the location of muskrat houses as well, there can be little doubt that it goes far toward controlling goose nesting, either directly or indirectly.

EGG PRODUCTION AND HATCH

Table 1 summarizes the data relative to the number of eggs and their ultimate fate. In eighty-four nests four hundred and ten eggs were laid, an average of 4.8. Frequency of occurrence by clutch size classes was as follows:

Size of clutch	2	3	4	5	6	7	8
Number of nests	4	3	21	32	20	3	1

A study of the first and of the last nine columns of Table 1 reveals the value of each vegetative type in relation to egg and brood productivity. It is of interest that the average clutch size differs in the several cover types

A.
hards

B.
lings
saltgr

A. (*Upper*)—Goose nest on a mass of hardstem bulrush.

B. (*Right*)—A successful hatch of five goslings in a nest on the solid base provided by saltgrass.

Alkali bulrush is shown to be unsuitable for Canada goose nests unless supplemented by the firm foundation provided by muskrat structures.

PLATE 8

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muskrat

and that nests in saltgrass lead in both clutch size and total egg production.

It will be seen also from Table 1 that 81% of the four hundred and ten eggs hatched. Hatching in saltgrass (87%) was exceeded only in four nests on artificially constructed banks where the hatch was 100%. The percentage of hatching for other types was considerably lower, being 70%, 77%, and 79% for alkali bulrush, cattail, and hardstem bulrush, respectively.

EGG LOSSES

Seventy-nine eggs, or 19% of the total, failed to hatch. Infertility was the most common cause, being responsible for 6% of the losses. It was noted in seventeen nests. In most of these infertility was confined to single eggs, there being only one instance in which a whole clutch was infertile. This clutch is known to have been the latest one laid.

Losses resulting from desertion amounted to 4%, and involved five nests. Two instances occurred in which some of the eggs in a nest were destroyed and the remainder then deserted. Three complete clutches were abandoned. In one case the cause of desertion was undetermined, it being possible that our nest hunting was responsible. Activity by visiting photographers and the operation of a dragline caused the other two desertions.

Predation was not excessive, causing the loss of only 4% of the eggs. Of the probable predators in the area—California gull, weasel, skunk, and magpie—only the first was recorded as destroying goose eggs. The loss of three eggs in a clutch of four was charged against this bird. Other depredations could not be identified with any certainty. It is noteworthy that twelve out of the eighteen eggs destroyed by predators were located in alkali bulrush.

During the present study, losses from flooding were at a minimum, two nests involving 2% of the eggs being recorded as lost due to this cause. It is felt that such a small loss was very fortunate because upon occasion the water levels can be greatly altered by winds. As depicted in Plate 6-B, a considerable number of nests were found in the lower reaches of the marsh, or, in other words, in the outer fringes of the emergent vegetation. All of the eggs in these nests were believed to have been in danger of destruction by flooding had a strong south wind occurred during the period of incubation.

Of the losses listed in the column headed as "Other" in Table 1, one nest of six eggs was apparently pushed into the water by a muskrat. This interpretation is based on the fact that the nest site was covered by fresh vegetation dragged there by one of these animals, and that the eggs were found in the water beside the nest. Two other eggs were pushed out of a nest, probably either by a muskrat or by the sitting goose as she left the nest. Two instances of goslings dying in the egg after pipping were observed.

SUMMARY

1. The goose nesting period of 1937 on the Bear River Migratory Waterfowl Refuge was during April and May.

2. Ninety-five goose nests were found in an area of 5,000 acres, 2,000 acres of which had emergent vegetation that was of potential value for nesting cover.

3. The acreages and nesting percent-

ages by cover types listed below show the relative values of each type:

3 % of the area in hardstem bulrush had 30% of the nests.
26 % of the area in saltgrass had 25% of the nests.
6 % of the area in cattail had 21% of the nests.
59 % of the area in alkali bulrush had 20% of the nests.

4. In eighty-four nests with complete records, four hundred and ten eggs were laid, of which 81% hatched. Of the remaining 19%, 6% were infertile, 4% were deserted, 4% preyed upon, 2% flooded, and 2% destroyed by other causes.

5. The critical factor influencing choice of nesting sites is believed to be the presence of substantial bases upon which the nests can be constructed.

6. Muskrat houses have a marked influence on the location of nests. In alkali bulrush 68% of the nests were on muskrat houses; in cattail, 72%; and in hardstem bulrush, 33%. The last-named plant itself tends to mat and provide adequate foundations for nests.

7. Channels definitely influence the location of nests; 63% of the nests were within 30 feet of channels and 77% within 30 feet of open water (channels included).

8. The effect of predation on goose nesting was found to be negligible.

MANAGEMENT SUGGESTIONS

In view of the findings of this study the following management practices would seem of value at the Bear River Migratory Waterfowl Refuge:

1. The excavation of small channels, especially in the lower reaches of the marsh; these channels should be shallow with gently sloping banks.

2. The planting of cover plants, especially hardstem bulrush, along these channels in order to speed up the establishment of adequate bases for nests.

3. The maintenance of a sufficient muskrat population to provide plenty of muskrat houses for nesting sites. It is recognized that too large a muskrat population may be detrimental to dikes and spillways.

4. The experimental building of mounds simulating muskrat houses; these should be restricted to the lower marshes and be covered with a mat of old vegetation.

Cecil S. Williams
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Brigham City, Utah

WINTER AND SPRING STUDIES OF THE SHARP-TAILED GROUSE IN UTAH

William H. Marshall and Max S. Jensen

One of the most striking examples of reduction in game bird populations in the western United States is afforded by the Columbian Sharp-tailed Grouse, *Pedioecetes phasianellus columbianus*. Early settlers observed thousands of these birds on the grassy benchlands of the Rocky Mountain area; now few are seen. State Game Commissions have prohibited hunting of these birds but still they are disappearing or barely holding their own.

One of the original projects of the Cooperative Wildlife Research Station at the Utah State Agriculture College in Logan, Utah, was an intensive study of the last remaining groups of these birds in northern Utah. The following report presents data gathered during field work in Cache Valley and vicinity, that was largely financed by that organization.[1]

Dr. D. I. Rasmussen, who is in charge of the cooperative station, has correlated the studies which are here presented and taken a leading part in the field work. Orville S. Lee, a graduate student, made a preliminary life history study and his report (1) specialized on past range and populations of the bird in comparison with those of 1935. In the spring of 1936 the senior author, as a member of the college faculty and with the assistance of members of the wildlife management classes, initiated more intensive studies which were carried on through the winter of 1936–37 by the junior author. (2) Other persons, particularly A. D. Smith, instructor in range management, who assisted in plant identification, and Lee Kay of the Utah State Fish and Game Department, who took motion pictures of mating activities, have aided materially in the study.

The apparent failure of hunting restrictions to "bring back" or maintain sharptail populations in Utah pointed to causes other than the gun as primarily responsible for reduced numbers. Accordingly field studies have stressed the following points in an effort to evaluate the real causes:

1. Survey of present range and numbers of the birds.
2. Characteristics of the vegetation in the areas where the birds are still found.
3. Observations on the relation of the birds to this vegetation.
4. Other factors in relation to the activities of the birds.
5. The requirements and habits of the birds as they affect activity in relation to vegetation.
6. The influence of other animals and man on the bird populations.

Intensive field work was done in the spring of 1936 and the winter of 1936–37. It was confined to an area of about eight thousand acres in the southern part of Cache Valley which lies near the

[1] The Utah Cooperative Wildlife Research Station is a joint project of the U. S. Biological Survey, American Wildlife Institute, Utah State Agricultural College, and the Utah State Fish and Game Department.

center of the territory shown in the accompanying map (Plate 9).

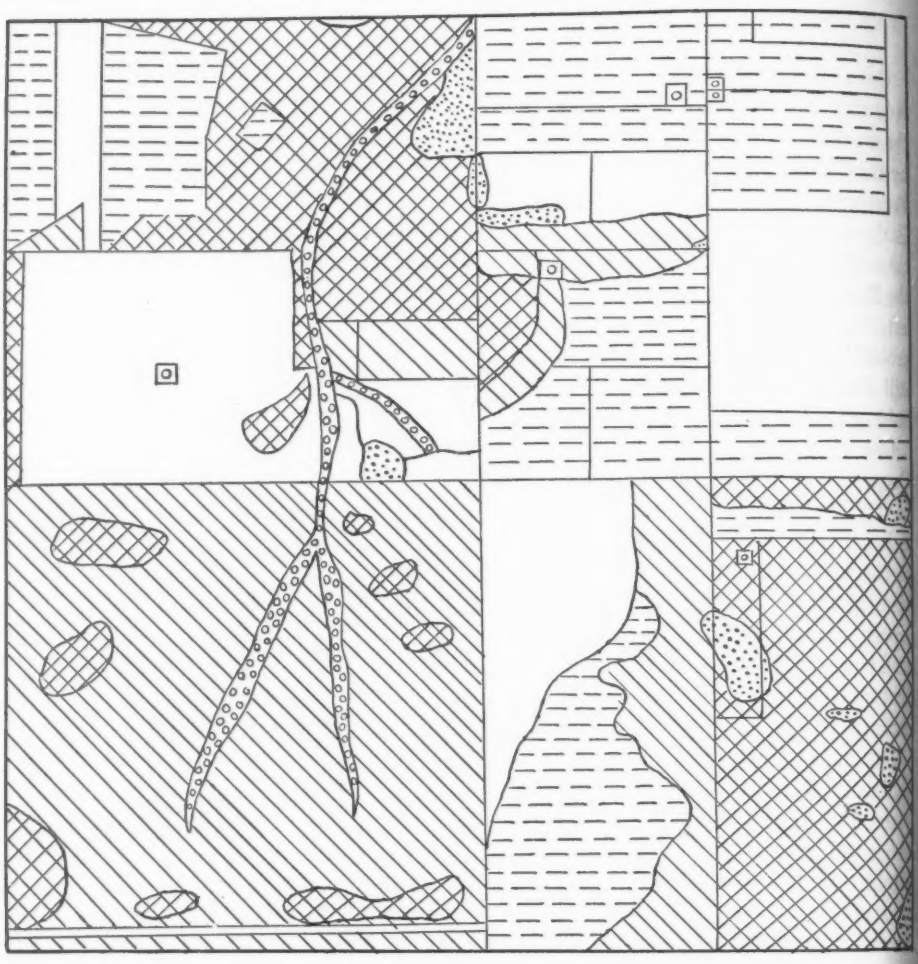

Fig. 1. Cover map of one square mile in southern Cache Valley, Utah. Spring 1937.

PRESENT RANGE AND NUMBERS

Observations by Lee showed that the sharptail is present only in scattered groups in the five northernmost counties of the State and that in 1935 there were about fifteen hundred birds in all. Subsequent field work has verified this total though there have been shifts in the numbers of different groups.

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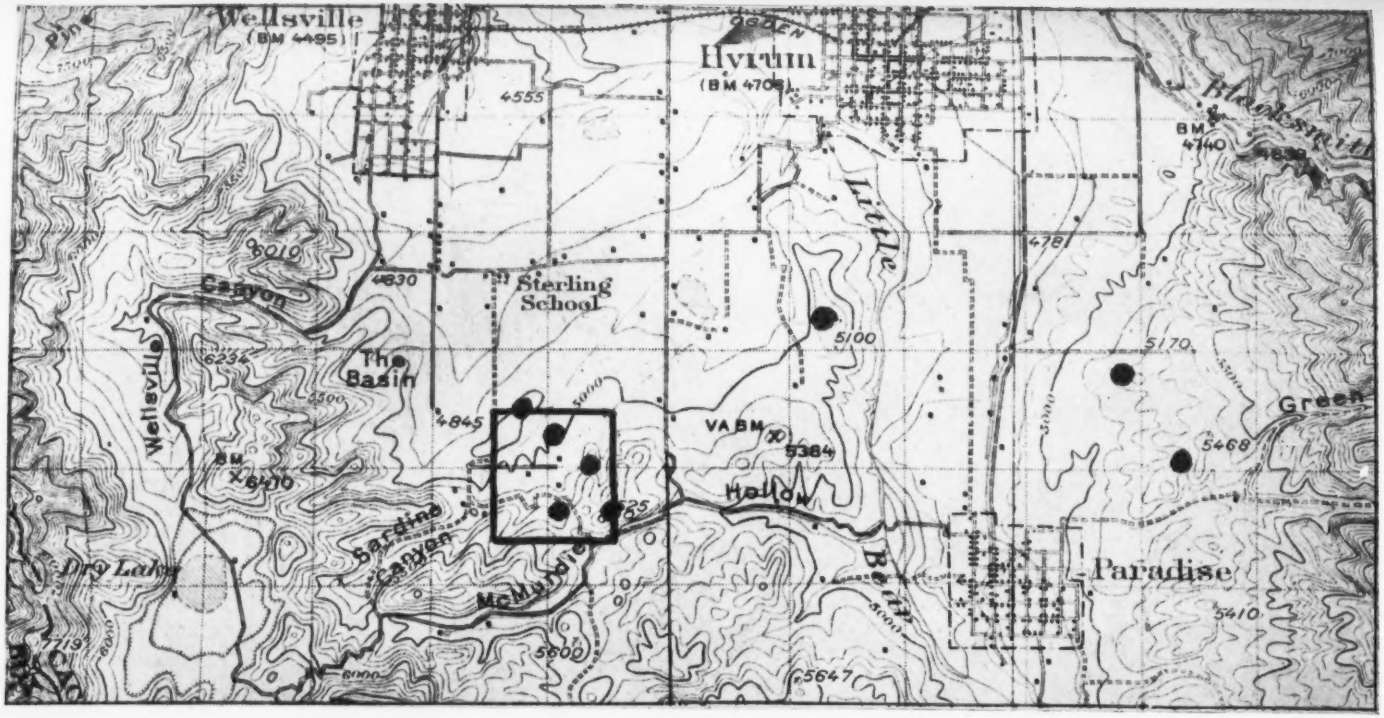


Topographic Map of southern Cache Valley, Utah
(● Represents a sharptail dancing ground.)

UNIV. OF MICH.

VEGETATION OF AREAS SUPPORTING SHARP-TAILED GROUSE

Field work demonstrated that the sharptail occurs where vegetative islands of certain characteristic cover types are present. In general these are on benchlands of rolling topography distributed irregularly in patches between dry farm fields of wheat and alfalfa. Plate 9 indicates the topography of two townships where some four hundred birds exist. The large dots represent dancing grounds about which the birds range during most of the year. Figure 1 presents the results of a survey of the cover types in the square mile outlined in black on the first map. Observations based on the flushing of birds indicate that the sharptail used these cover patches intensively during the period under consideration.

The following plants found most frequently upon the study area are grouped by the cover types used in the taking of field notes.

Sage-grass type

Agropyron pauciflorum	Koeleria cristata
Artemisia tridentata	Melica bulbosa

Sage-weed type

Achillea lanulosa	Chaenactis douglasii
Agropyron pauciflorum	Helianthella uniflora
Artemisia tridentata	Helianthus annuus
Astragalus ciliaris	Lappula floribunda
Bromus tectorum	Poa secunda

Grass-weed type

Achillea lanulosa	Astragalus ciliaris
Agropyron pauciflorum	Balsamorrhiza macrophyllum
Artemisia gnaphalodes	Balsamorrhiza sagittata
Grindelia squarrosa	Pentstemon cyananthus
Gutierrezia sarothrae	Poa secunda
Helianthus annuus	Wyethia amplexicaulis
Leptotaenia multifida	

Maple-chokecherry type

Acer grandidentatum	Prunus melanocarpa
Helianthella uniflora	Sidalcea nervata

These types, with the exception of the sage-grass, are nearly all grazed severely. Apparently the transition from the sage-grass to sage-weed types is one brought about by overgrazing, the former type being more nearly like the original cover. Often the maple-chokecherry type is overgrazed because livestock is localized there in late summer by the attractions of shade and of the few remaining waterholes.

It is noteworthy that though they have been grazed and burned, in some instances heavily, these patches are unplowed and have undoubtedly been left because of their rockiness or uneven topography. In view of this fact they are referred to as native cover in distinction from the cultivated fields.

RELATION OF GROUSE ACTIVITY TO VEGETATION

Due to the inability to observe undisturbed birds and to the wariness of the sharptail, cover-type relationships were studied chiefly on the basis of flushed birds. Each field observation was recorded as to date, time, cover type, flushing distance, and numbers of birds, and entered on cover-type maps. Remarks on other items noted also were recorded on a form prepared for the purpose. At times circumstances permitted observations on activity before

FIG 2
GRAPH SHOWING COVER TYPE USE & TABLES SHOWING AV. COVEY SIZE & AV. FLUSHING DISTANCES OF SHARPTAIL GROUSE DURING THE WINTER & SPRING PERIOD.

MONTH DAY	OCT. 16-31	NOV. 1-15	NOV. 16-30	DEC. 1-15	DEC. 16-31	JAN. 1-15	JAN. 16-31	FEB. 1-16	FEB. 16-28	MAR. 1-15	MAR. 16-31	APR. 1-15	APR. 16-30	MAY 1-15	MAY 16-31
AV COVEY SIZE	32.3	12.7	17.3	35.9	2.7	—	4.9	6.7	8.3	18.0	13.3	3.8	5.6	9.6	8.1
AV. FLUSH DISTANCE (Feet)	66	38		132		138		60		86		45		20	

the birds flushed, and a study of mating behavior was carried on from blinds.

Figure 2 summarizes data on flushes by fifteen-day periods for the months that field work was done and points to the following conclusions:

1. During the late fall and early winter months the birds use the sage-grass and sage-weed types to a considerable extent.

2. Beginning in late December the birds started to use the maple-chokecherry type and were in this cover almost exclusively during January and early February.

3. In March the birds shifted again, this time to the weed-grass type with some use of both the sage-grass and sage-weed types and also of the wheat stubble.

4. Late in April, as the alfalfa attained sufficient height to afford concealment, a move to this cover began. Use of the native cover types, especially for mating activities, however, continued.

5. The tendency toward use of alfalfa increased during May.

There are certain correlations with other information, to be discussed later, that can well be pointed out at this time:

1. The shifts to and from the maple-chokecherry type parallel changes in snow depth and in elevation (Fig. 3).

2. The large percentages of observations of birds in the weed-grass type, as shown in Figure 2, during April and May may be attributed to mating activities.

3. There is marked variation in diet according to the cover type used.

Relation of Grouse Activity to Other Environmental Factors

Analysis of Figure 2 indicates a seasonal variation in range especially as related to cover types which is apparently the result of snow depth, though other climatic factors not studied may have an influence.

Figure 3 presents official data on total snow depths at Logan, Utah, during the period of the study. Accompanying the curve of snow depths is one showing the elevations at which the birds were found during the same period. The maple-chokecherry cover-type areas used in January and February were all at the higher elevations. In some localities, such as at Eden, Utah, where suitable high-brush types are only in the bottoms, the altitude-range-frequenting relationship is reversed, strengthening the conclusion that cover-type preference governs these movements.

Data obtained by scaling on cover maps the locations of birds with respect to the nearest open water fails to indicate that there is a definite requirement for such water. During October the average distance of flushes from open water was three-tenths of a mile; this increased to two and two-tenths miles in January when all springs and seeps were covered by snow, and decreased again to five-tenths of a mile in April and May. At no time has evidence of direct use of open water been found, though every opportunity was taken to inspect spring and mud holes both for birds and tracks.

Requirements Affecting Cover Relationships

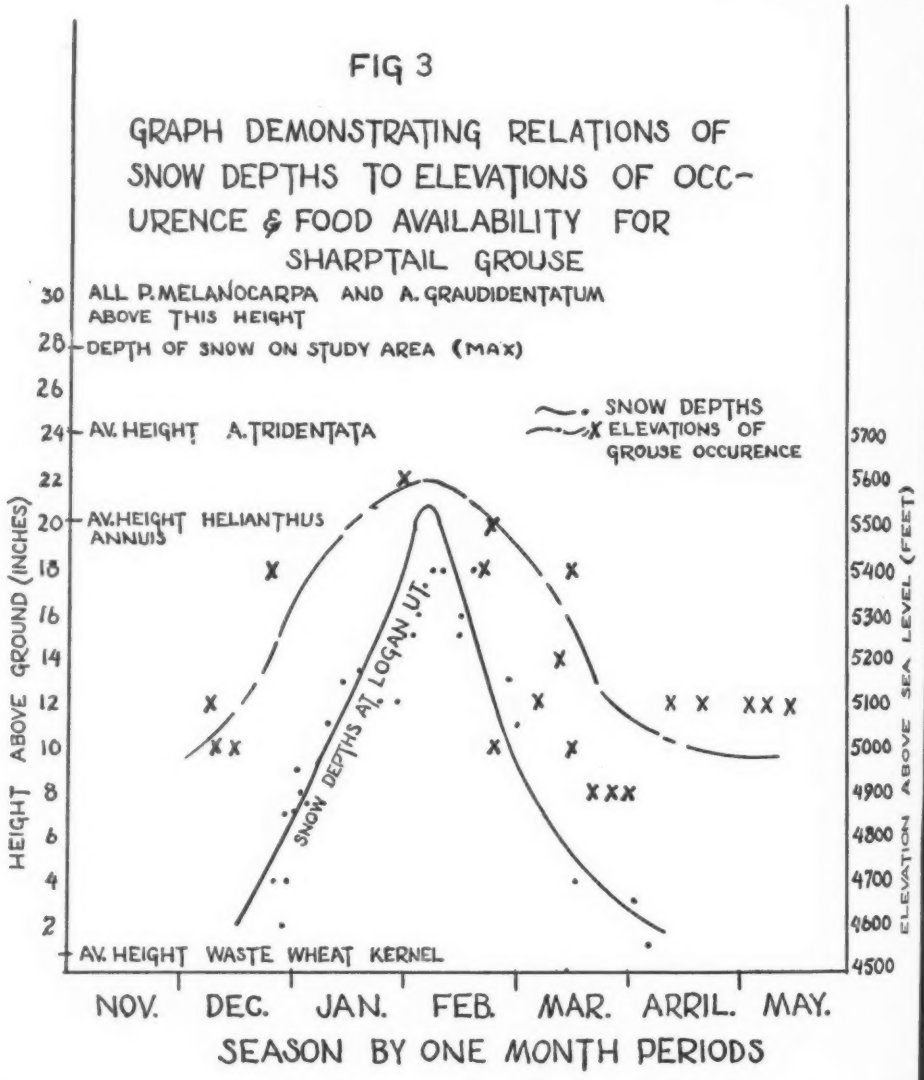
Habits of the birds which might in-

fluence cover-type preferences were studied whenever possible.

An attempt has been made to express in the inner circle the relationships of

FIG 3

GRAPH DEMONSTRATING RELATIONS OF SNOW DEPTHS TO ELEVATIONS OF OCCURENCE & FOOD AVAILABILITY FOR SHARPTAIL GROUSE



Routine

Figure 4 presents a schematic picture of the routine of the sharptails for a typical winter and spring day. While admittedly generalized, it is believed that the ideas conveyed are of value. these activities to cover by generalizing the field observations summarized in Figure 2.

Roosting

Cover requirements, as shown in Figure 3, apparently varied largely with

snow depths and crust conditions. When there was no snow the birds were found using both the sage types and the weed-grass type. As snow covered up the latter, they shifted to the sage types and even when the sage was covered, they would use this type, if there was no crust, by diving or burrowing into the snow often until they were in the branches of the sage brush. Heavy snow crusts in January and February caused the birds to roost in bushes that were above the snow; since maple and chokecherry were the only ones present on the area, they were the ones used.

Resting

As indicated in Figure 4 for the spring period resting was done in the grass-weed type or in alfalfa when that had reached sufficient height. Forms made by the birds during the middle of the day could be readily found at this time. Observations indicated that the birds were dusting in these forms. Table 1 presents data on this point gathered on April 24, 1936. It is apparent that the birds preferred to be under Agropyron, which is a native bunchgrass, or under Gutierrezia and Artemisia, which are perennial herbs. These three species are predominantly "bunchy" in growth character.

TABLE 1
RELATION OF RESTING FORMS TO PLANTS

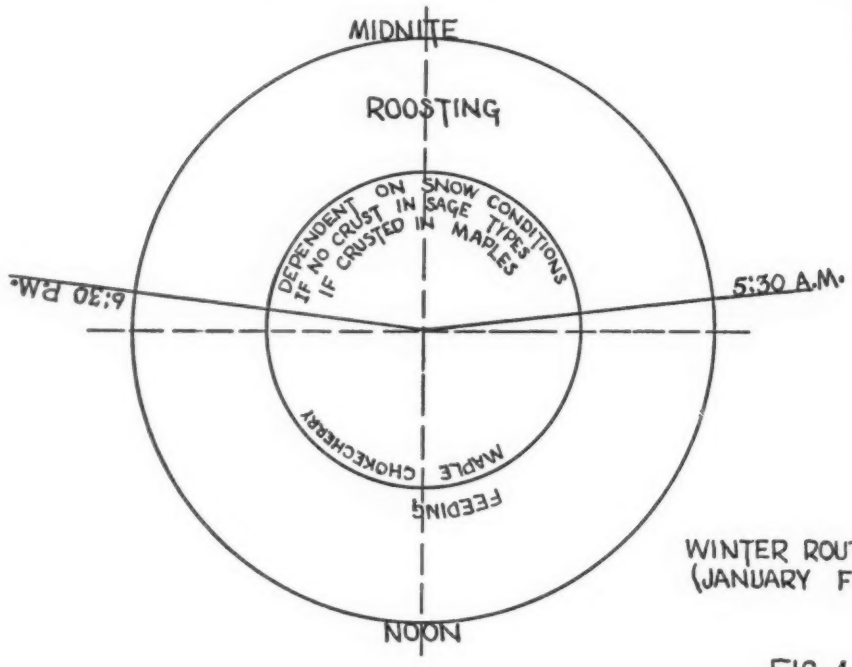
Species	*Number a foot or more distant*	*Number of forms under the plant*
Agropyron pauciflorum	0	16
Gutierrezia sarothrae	1	9
Artemisia gnaphalodes	0	8
Bromus tectorum	0	3
Artemisia tridentata	0	2
Helianthella uniflorum	0	1
Sisymbrium altissimum	0	1
Total	1	40

Covey Size

The question of coveys and packs of sharptails is a difficult one to answer on the basis of information gathered during this study. Observations recorded in Figure 2 show that there is wide variation in average covey size. During each of the fifteen-day periods of the study, birds were flushed in groups of three or less. On the other hand, large packs were the rule in November and December, one of 120 being seen on the eighth of December; the average for the first half of this month was thirty-six birds per group. Average covey size decreased during the last half of January and the fortnights of February to approximately five, seven, and eight respectively, the largest covey noted being twenty-four. In the halves of March the average rose again to eighteen and thirteen, phenomena probably connected with mating activities. For April and May the averages are lower because during the day at that season the birds scattered. Nevertheless, maximum groups remained above thirty as early morning observers found the birds assembled at dancing grounds.

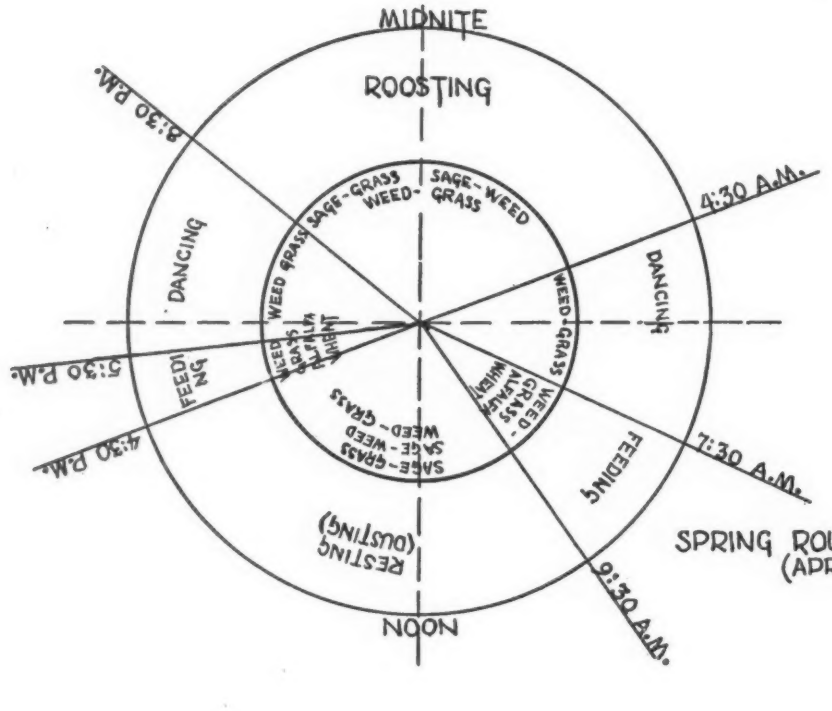
Flushing Distance

The sharp-tailed grouse is rated by the older hunters as one of the wariest of the local birds. To gauge their shyness, flushing distance records were kept during the study and are summarized in the lower strip of Figure 2. Considerable seasonal variation, 20 to 138 feet, is shown but examination of records does not indicate close correlation with differences in cover types. During winter when poaching might be considered probable, distances were usually well over effective shotgun range. It is not



WINTER ROUTINE CHART
(JANUARY FEBRUARY)

FIG 4



SPRING ROUTINE CHART
(APRIL)

known whether the high figures for January and February are a result of greater visibility due to snow or of molestation by rabbit hunters in the area at that time. The average flushing distance decreased rapidly in April and May when green plants increased the available hiding places.

Mobility

The mobility of the sharptail has been studied by analysis of observations recorded on cover maps. Notes on the birds on the eastern side of the valley indicate that they were found about a mile north of the northernmost dancing ground on that side during the winter months; and that ninety per cent of observations during April and May were within a half-mile radius of the weed-grass plots used as dancing grounds.

Apparently the daily cruising radius of this group is about a half mile, while the annual radius is at the most two miles. Observations on other groups, though less complete, are similar. The phenomena of mobility seem to be a function of reactions to cover types, elevations, depths of snow, and food availability.

Food Preferences

Table 2 shows for each month of the study the frequency of use of various foods based on three types of notes, namely: dropping analyses, field observations on actual feeding, and interpretation of tracks and other signs on the snow.

The dropping analyses were made in the laboratory by washing droppings through a piece of silk mesh stretched over a tin cup that had no bottom and examining the materials left on the silk with a low power binocular microscope. Field observations on feeding were possible at times, particularly during the mating season when birds were observed at close range from blinds. Tracking observations were possible during the winter only; conclusions as to the nature of the food eaten were on the basis of particles scattered on the snow as well as on the location of the tracks.

Availability of food apparently influenced the food habits greatly. Only once has evidence been obtained that the sharptail digs or scratches for food; thus, as snow depths increase or decrease, certain foods in turn lose or maintain availability. The heights of the important foods above the ground are charted with snow depths for the winter period in Figure 3. Peak snow depths in the study area were considerably greater than those in Logan which is fifteen miles away. Attention is called to the correlation of changes in foods eaten with snow depths. During May the return of insect availability is indicated by the records of insect remains in droppings.

TABLE 2

MONTHLY RANK OF PRINCIPAL FOODS BASED ON FREQUENCY OF USE

October
1. Wheat
2. Sunflower (*Helianthus annuus*)
3. Grass (seed heads)
4. Dandelion (*Leontodon taraxacum*)

November
1. Wheat
2. Sunflower
3. Grass (seed heads)
4. Dock (*Wyethia amplexicaulis*)

December
1. Sunflower
2. Wheat
3. Sagebrush (*Artemisia tridentata*, seed heads)

4. Chokecherry (*Prunus melanocarpa*, buds)
   (Some Aster and *Grindelia squarrosa*)

January
1. Chokecherry (buds)
2. Maple (*Acer grandidentatum*, buds)
3. Sagebrush (seed heads)
4. Sunflower
   (Some *Rosa* spp. and *Salix* spp.)

February
1. Chokecherry (buds)
2. Maple (buds)
3. Grass (green blades)
4. Dock
   (Some Artemisia and *Achillea lanulosa*)

March
1. Wheat
2. Grass (green blades)
3. Yarrow
4. Dock
   (Some Artemisia, Prunus, and Acer early in month)

April
1. Wheat
2. Alfalfa
3. Grass (green blades)
4. Insects (Coleoptera, Formicidae)
   (Also Artemisia, Achillea and Wyethia)

May
1. Alfalfa
2. Wheat
3. Orthoptera (*Melanoplus mexicanus*)
4. Grass (green blades)
   (Also Compositae, Carabidae, Coccinellidae, and other Coleoptera)

Mating Habits

Perhaps the most exacting requirement of the sharptail for cover is evidenced during the mating season. Detailed studies of this relationship were carried on during 1936; a more extensive survey of dancing grounds in the entire area was made in 1937.

Seven dancing grounds were found as shown in Plate 9. These agreed in that they were on the tops of ridges or knolls and in the weed-grass cover type. One knoll, used by about twenty-five birds in 1936 was not occupied during 1937, probably because a very hot fire burned over this area on June 17, 1936 and destroyed practically all of the cover.

In 1936 the mating activities were first observed on April 23 but had evidently been going on for some time. Observations in 1937 indicated that they began in the last week of March. In 1936 dancing continued until about the first week in June on the single dancing ground that was watched closely, though activity was reduced during the last few weeks of the period.

At the time dancing starts, snow may still be on the grounds, though most of them are bare. Only the tiny *Collinsia tenella* and scattered *Viola purpurea* were found flowering on the hills early in April. By the end of the dancing period vegetation is well grown and tends to hide the birds; at this time there are well beaten, dusty paths between the larger plants such as *Wyethia amplexicaulis*.

There are two periods of dancing each day which seem to be conditioned by light intensity. Table 3 presents data on the 1936 observations as to the time the morning activity begins and the official time of sunrise on the same days.

TABLE 3

RELATIONSHIP OF THE BEGINNING OF DANCING TO TIME OF SUNRISE

Date	*Dance Begins*	*Sunrise*	*Weather*
4/26	4:52	5:35	Clear
4/27	4:52	5:34	Cloudy
4/28	4:53	5:33	Cloudy
4/29	4:52	5:31	Cloudy
5/3	4:38	5:26	Cloudy
5/16	4:30	5:11	Clear
5/17	4:23	5:10	Clear
5/27	4:15	5:03	Cloudy
5/29	4:03	5:02	Clear

The evening dance begins between five and six p.m. and continues until

darkness settles. A captive bird has been known to display and make characteristic sounds during an entire night when there was a full moon, but such behavior has not yet been observed in the field. Rain has been known to inhibit dancing both in the morning and evening. On two occasions a severe dust storm in the afternoon, however, did not deter the birds from dancing. Hawks, flying over, usually stop the dancing; they have not been seen to molest the sharptails.

The reader is referred to Roberts (3) for a detailed description of the dancing itself; though this description is of the prairie sharptail, it is in nearly identical agreement with notes, descriptions, and photographs obtained during the past two seasons in Utah.

RELATIONS OF GROUSE TO OTHER ANIMALS AND TO MAN

Though no attempt has been made to compile complete lists of animals present on the area, notes were taken on other species and their activities. Particular attention was paid to possible competitors and predators.

Among birds the following species were common:

Fall and winter months: Horned lark, pale goldfinch, pheasant, Bohemian waxwing, chickadee, magpie, crow, and rough-legged hawk.

Spring months: Mourning dove, mountain bluebird, western robin, western meadowlark, redwing blackbird, Brewer's blackbird, junco, pine siskin, magpie, goshawk, sparrow hawk, Swainson's hawk, redtailed hawk, marsh hawk, golden eagle, and short-eared owl.

During the entire period coyotes, mountain weasels, and western white-tailed jackrabbits were observed. Mule deer and porcupines were seen in February, while skunks, marmots, and Uinta ground squirrels were observed in the fall and spring.

Field observations indicated that there was direct competition by sharptails with the horned larks, pine siskins, pale goldfinches, and pheasants for weed seeds, especially those of *Helianthus annuus*. Crows and pheasants were observed eating wheat at the same time the dropping analysis showed the grouse were using this food. Juncos and waxwings consumed buds of the chokecherry that are of value to the sharptail. The western white-tailed jackrabbit was observed feeding on chokecherry branches during the periods of deep snow and may have competed with the sharptail at those times. The Uinta ground squirrel and marmots ate alfalfa and grass that was of value to the birds in the spring months.

No attempt at a quantitative evaluation of this competition was made. It is believed, however, that the competition for weed seeds and chokecherry buds may have been important during the fall and winter.

Evidence of predation and its importance was equally hard to evaluate. The numerous hawks and the golden eagles present in the spring often stopped dancing activity. One carcass of a sharptail with the head and neck eaten, was found by a fence post near a dancing ground and the kill was attributed to a winged predator. Two direct observations on coyote predation during early morning mating activity were obtained. One student studying mating habits from the top of a haystack adjacent to the eastern dancing grounds

in May, 1936, saw a coyote spring out from concealment in the vegetation and catch a sharptail just after it flew off the ground in its effort to escape. The coyote immediately left the dancing ground with the bird and in several minutes dancing was resumed. Because of its value in demonstrating predator action, Jensen's note taken in a blind on April 29, 1937, is quoted: "The sharptails suddenly ceased their dancing activity as a coyote approached, jumping high into the air as he came. The grouse flushed about twenty yards ahead of him but immediately lit a few yards behind or to the side of him. After a few minutes he caught my scent and ran rapidly away. Immediately a second coyote approached but used entirely different tactics in an effort to catch one of the dancing grouse. This animal crawled slowly towards the grouse and when they flushed before him would lie perfectly quiet until they resumed activity. This coyote stalked the grouse for ten minutes but with very little success and then caught my scent and disappeared in the same manner as the first animal." In May of 1936, remains of two birds, apparently killed by skunks, were found. No other evidence was obtained, though coyote and skunk droppings were examined rather thoroughly throughout the study.

Farming and grazing are detrimental in destroying native cover. There was some poaching by rabbit hunters during the winter, but this was apparently not of great importance. It is interesting to note that though one of the dancing grounds is less than half a mile from a main highway, the passing of trucks and cars did not inhibit mating activity, though once an airplane did.

At present all of the farmers on the study area are intensely interested in the groups of "prairie chickens" as they are known locally, particularly those on their own property.

Through Lee's efforts, a refuge was established in 1935 which covers most of the study area, and plans are under way for leaving standing wheat for winter food in several parts of the district.

SUMMARY

1. Data gathered during 1935, 1936, and 1937 on the ecology of the sharptailed grouse in the northern part of Utah are presented.

2. There are at present approximately fifteen hundred of these birds in the State, scattered in small groups through the northernmost five counties.

3. The grouse occur only where certain characteristic islands of native vegetation are found and the activities of the birds center in these islands during the winter and spring.

4. There is a seasonal variation in cover type-activity relations, daily routines, and roosting requirements.

5. There is no evidence of a requirement for open water.

6. Bunchy vegetation is essential to resting and dusting.

7. Coveys are not definite and fall packing was noted.

8. The daily cruising radius is probably a half mile and the annual about two miles.

9. Food preferences are apparently largely influenced by availability.

10. Mating activity is dependent on dancing grounds having certain characteristics and is influenced by light, climatic conditions, and predation.

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THE COVER MAP IN WILDLIFE MANAGEMENT[1]

Paul D. Dalke

The methods employed in making cover maps vary from those showing only the broad types of cover to intricate systems for the most part impractical. Wight ('34) developed a system of cover mapping for the purpose of wildlife management based upon the ecological succession of plant associations. The correlation of the major plant associations into an orderly arrangement of ecological succession is the working basis for this system of cover mapping. This system has been used successfully in Michigan for the past five years and its simplicity and ease of interpretation are rapidly bringing about its use in several other sections of the country.

In regions where the ecological succession of plant communities has been determined, much of the data necessary for a cover mapping legend are already available. Nichols ('13a, '13b, '14, '15, '16) and Lutz ('28) in discussing the vegetation of Connecticut and upland succession in southern New England, present data that have been very helpful in the defining of types for a mapping system. Cover types based upon ecological succession are now used in Connecticut and are well adapted to other eastern localities.

The U. S. Geological Survey topographical sheets have served as the basis for all maps of the state since Connecticut was first surveyed some 40–50 years ago. Since then, many changes have taken place in the landscape. The State Planning Board initiated an aerial mapping program for the entire state about three years ago. The aerial maps (Plate 10) have proved very valuable and for many purposes, superior to the U. S. Geological Survey topographical sheets. The aerial maps have the advantage of being available in several sizes, roads and streams are accurately shown, and wooded areas of both conifers and hardwoods are easily recognized. They also show in farm territory, the large number of fences and stone walls that could otherwise be mapped only with much difficulty. The aerial mosaic prints not only solve the problem of accurately locating fences and stone walls, but facilitate the identification of the boundaries of seepage or periodic swamp areas regardless of the kind or amount of cover occurring on them. Since seepage areas are used mostly for pastures, the cover is usually either shrubby, herbaceous, or with a light mixture of tree species (Plate 10).

The mosaic maps are available for the entire state and are now used by several state departments. The most practical size seems to be the 19″×25″ sheets with a scale of 1″ = 1,200′ or 4.4′ = 1 mile. This size mosaic print represents five minutes of latitude and longitude. The scale gives good results in cover mapping and because of the small size of fields in the farm-game areas, it

[1] The author wishes to acknowledge the helpful criticisms and suggestions of Prof. H. M. Wight, Dr. R. E. Trippensee, and Dr. P. F. English, in the preparation of this paper.

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Scale 1″ = 1200′

Aerial map—an excellent base for cover maps
(Courtesy Fairchild Aerial Surveys, Inc.)

UNIV. OF MICH.

is our experience that a field map on a smaller scale is impractical.

The location of each mosaic print is easily accomplished by the aid of a small guide to all the U. S. G. S. quadrangles occuring within the state. In addition to the latitude and longitude marks on the corners of each mosaic, the quadrangle number and the number within the quadrangle appears in the lower right hand corner. Each U. S. G. S. quadrangle requires nine of the mosaic prints, which are numbered from left to right as follows:

1	2	3
4	5	6
7	8	9

In the preparation of base maps for field use (Plate 11) tracings are first made of the aerial mosaic maps. The principal features of the landscape are outlined in ink and the boundaries of the fields and woodland are traced in pencil. Brown line prints are then made for use as base filed maps. Where boundaries of fields, woodland, or other areas need correcting, the pencil lines can be easily erased and the correction made on the office tracing at the time the cover map symbols are put on. The resulting cover map is then correct in all details. Symbols for roads, trails, fences,[2] streams, etc., conform to accepted map standards.

Connecticut is not included in the rectangular system of land surveys and in order to facilitate the recording of field data for management purposes, a grid of lines running north-south and east-west has been arbitrarily drawn on each base field map (Plate 11). The resulting squares are designated by numbers and letters and represent approximately 20 acres each. Frequently it is important to indicate an exact spot within a 20-acre area. These squares, which have been ruled off as solid lines are further divided into-5-acre areas by dotted lines as shown in Plate 11. It is possible then to confine the recording of field observations within a definite 5-acre unit. For the convenience of the field worker, 5-acre units within each 20-acre square are numbered as follows:

1	2
3	4

The complete notation for the exact location of any observation can be written as a fraction, the numerator expressing the location within any given area and the denominator indicating the number of the quadrangle and the sheet number within the quadrangle. $\frac{(6\ B\ 4)}{(21–4)}$ represents the location of a small pond in the southwest portion of the map in Plates 11 and 12.

COVER SYMBOLS

To facilitate the preparation of cover type legends the major plant associations are divided into those successions originating from land or upland types (xerosere) and those originating from lakes, ponds, streams, or swamp types (hydrosere). In addition to this broad classification, there is the seepage area, a periodic or permanent swamp originating from springs.

[2] In the area illustrated in this paper, practically all the fences are stone walls. Because of the small size of fields, the conventional symbols for stone walls would occupy too much space. A solid black line was used on this particular map as a stone wall symbol.

Plant Succession Symbols
Origin from land (xerosere)

A4	Herbs	A11	Pine or spruce plantation
A5	Shrubs, deciduous	A12	Hardwood plantation
A5e	Shrubs, evergreen	A13	Oak-hickory-red maple-ash
A6	Gray birch	A14	Hemlock
A7	Red cedar	A15	Mixed hardwoods and conifers (oak-hickory-birch-maple-pine-hemlock)
A8	Pitch pine		
A9	Aspen		
A10	White pine	A16	Beech-birch-maple-hemlock.

Origin from open water (lakes, ponds, and streams; hydrosere)

Marsh Phase		*Bog Phase*	
B1	Submerged vegetation (pond weeds)	E1	Sedge-sphagnum-loosestrife
B2	Floating vegetation (water lilies)	E2	Shrubs (heaths)-sphagnum
B3	Emergent vegetation (bulrushes)	E3	Tamarack-spruce
B4	Sedges-grasses		
B5	Shrub-herb-sedge		
Wooded Swamp Phase		*Stream Flood Plain*	
B6	White cedar or tamarack	P1	Emergent vegetation
B7	White cedar plantation	P2	Mixed herbaceous
B8	Red maple-yellow birch-black ash	P3	Shrub (willow-dogwood-alder)
		P4	Willow-cottonwood-elm-silver maple

Seepage-Swamps (periodic or permanent spring swamps)

C1	Sedge-grass-herbs	C3	Spirea-shrubby cinquefoil
C2	Alder-dogwood-willow	C4	Red maple-elm-birch-blue-beech hickory

Other Symbols

Fence row plant densities		*Timber Density*		*Understory or shrub density*	
Clear or light	|	Scattered	|	Scattered	–
Medium	||	Medium	||	Medium	=
Heavy	|||	Heavy	|||	Heavy	≡

Timber Age	*Cropped Land*	*Vegetation in Fence Rows*
0– 10 years—1	al—alfalfa	s—shrubs
11– 20 years—2	cn—corn	t—trees
21– 40 years—3	gr—garden	h—herbs
41– 60 years—4	pot—potatoes	m—mixed
61– 80 years—5	t—tobacco	
81–100 years—6	cr—cereals	
101–120 years—7	ve—vegetables	
A—all ages		

Plantation species and miscellaneous

wc—white cedar	c—cropped land
rp—red pine	or—orchard
wp—white pine	p—pastured
scp—Scotch pine	x—scattered conifers
ns—Norway spruce	⊗—scattered apple trees
ws—white spruce	tp—tulip poplar
wo—white oak	ro—red oak
wa—white ash	sm—sugar maple

UPLAND COVER TYPES

The upland succession is designated by a capital A followed by a number which represents a type or association. The cover types A1, A2, and A3, have been omitted because they concern

Plate

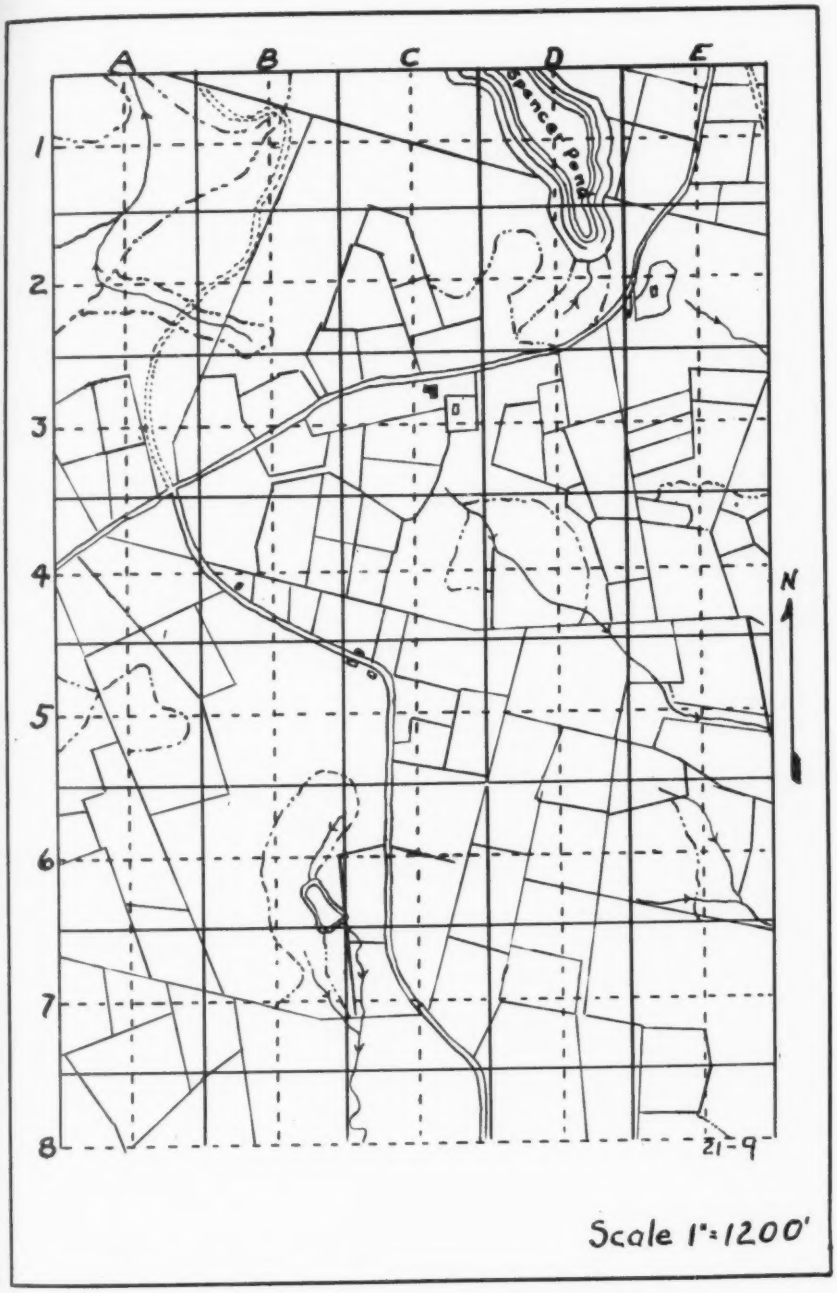

Plate 11. Field map with tracings of principal landmarks and grid of orientation lines.

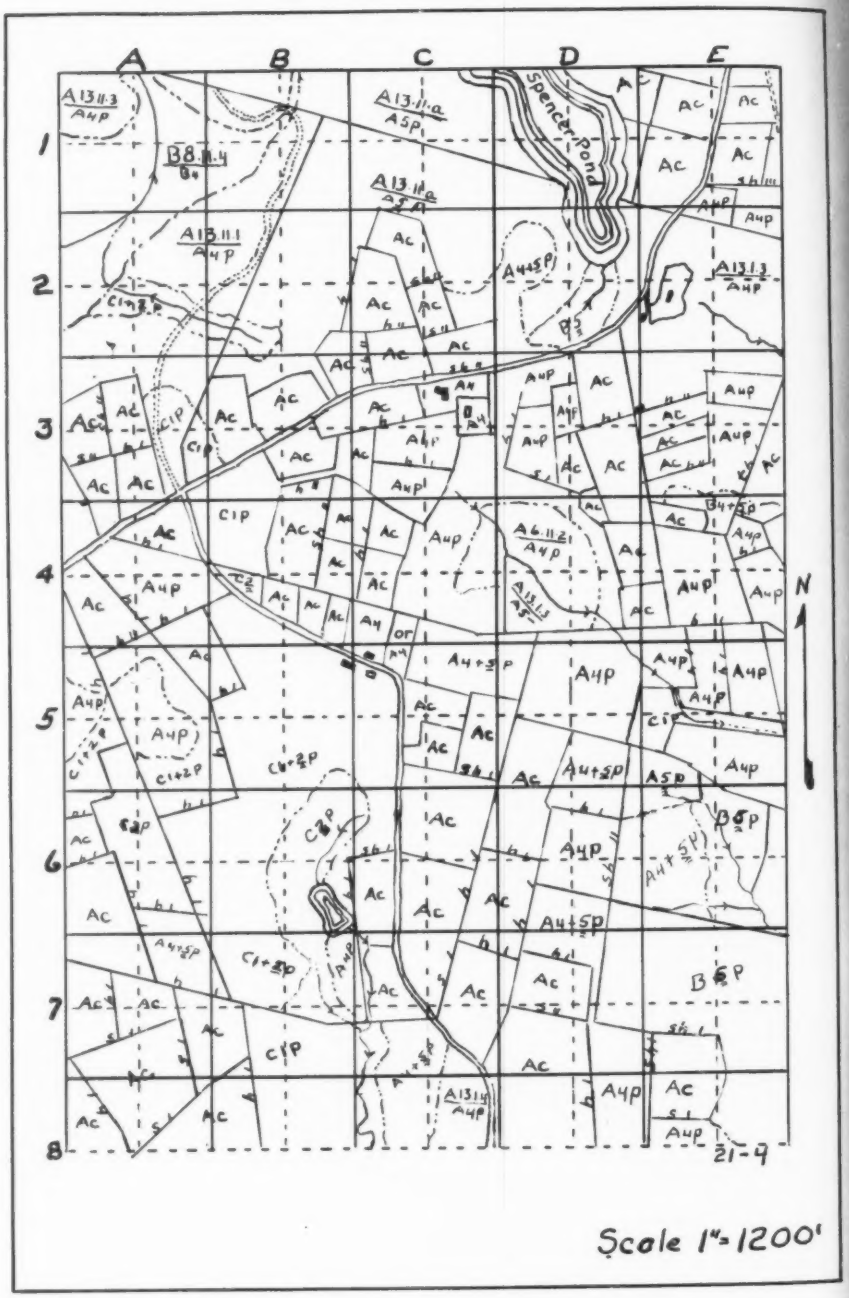

Plate 12. Completed map with cover symbols.

only the crustose and foliose lichens and mosses. For more detailed ecological work, however, they may be included.

The A4 type includes all herbaceous growth. The pasture and abandoned field are representative of this type. Areas in the A4 type are usually pastured, in which case the small letter *p* is added to the symbol.

The symbols for shrubs (A5 and A5e), indicate deciduous and evergreen species, respectively. In Connecticut the latter may be ground juniper, mountain laurel, or rhododendron. In areas where two species are about equally represented as for example gray birch and red cedar, the symbols are combined as A6&7. In areas where one species forms at least 80% of the stand, only one is indicated, unless occurring as an understory. In wooded areas both the timber species in the overstory, and shrub species in the understory are shown by symbol. The former occupying the numerator of the fraction and the latter the denominator, as for example $\frac{\text{A 13}}{\text{A 10}}$ or $\frac{\text{A 13}}{\text{A5e}}$.

There are numerous plantations of red, white, and Scotch pine, Norway and white spruce both on state and private lands. These plantations are designated by the symbol A11 with a subscript to indicate the species. Smaller areas of hardwood species are also to be found on state lands and these are designated by the symbol A12 with a sub-script for the species symbol.

The end series in the upland types is the climax forest usually composed of American beech, yellow birch, hard maple, and hemlock. On certain sites, the end series appears to be the oak-hickory association. The composition of the climax forest varies considerably in different parts of the state.

SWAMP COVER TYPES

The plant succession initiated from open water, marshes, or streams is all classified under swamp cover types. The term swamp is used in a generic sense and includes both the herb, shrub, and tree stages of the hydrarch succession. For convenience in cover mapping, the swamp is sub-divided into the marsh phase (which contains only the herbaceous and shrubby species), the wooded swamp phase, the bog phase, and the stream flood plain.

The B1, B2, and B3 cover types are of importance in waterfowl management. The B1 type includes only the submerged vegetation such as pond weeds. The B2 type is composed of the species whose leaves float on the surface such as waterlilies. The B3 type is characterized by emergent vegetation represented by bulrushes, pickerel weed and cattails. The B4 cover type of sedges and grasses is common and constitutes some of the best winter pheasant roosting sites. The B5 type is also useful as cover for pheasants if not too much overgrown with shrubs.

The vegetation in a wooded swamp in the southeastern portion of the state may be either the coast white cedar or the typical red maple association. The B6 type contains tamarack if located in the northern part of the state, and coast white cedar if in the southeastern part of the state. The B8 type of red maple, yellow birch, and black ash is common throughout the state.

The bog phase of the swamp succes-

sion is classified into three types. The E1 type is made up mostly of sedge, sphagnum, and loosestrife. Following this initial stage is the E2 type or the shrubs and sphagnum. The shrubs in this type are mostly the heaths or ericaceous plants. The end succession, E3, of the characteristic bog vegetation is found in the tamarack-spruce association.

The succession of vegetation along the flood plains of the larger rivers such as the Connecticut and Housatonic is designated by the symbols, P1, P2, P3, and P4. While these cover types are very restricted in size and their occurrence is rather rare, they deserve a place in an ecological classification of plant types.

The seepage-swamp is the most common type of swamp in Connecticut and owes its existence to the relation between the topography and the ground water level. Seepage-swamps are usually situated in shallow depressions and on side hills where the water runs off as fast as it seeps to the surface. Where the ground water level is sufficiently high to allow a flow of water the year round, the swamp is known as a permanent spring- or seepage-swamp. Where the ground is saturated with water at certain seasons and dry at others, a periodic seepage-swamp exists.

The initial stage in either the periodic, or permanent, spring swamp is the sedge, grass and herbaceous association (C1). The shrub stage (C2) which follows is similar to the lake-swamp shrub stage and is characterized by swamp alder, dogwood-poison sumac-willow and spirea. In the northwestern portion of the state, a separate shrub association is very common and is designated as the spirea-shrubby cinquefoil type (C3). The tree stage (C4) of the seepage-swamp may contain any of the species characteristic of a permanent swamp such as red maple, American elm, yellow birch and also blue beech, hickory, tulip-tree, and sycamore.

The character of the vegetation growing along fence rows or stone walls is designated by a system of vertical lines (|, ||, and |||) indicating a sparse, medium, or heavy vegetation. Symbols of s, t, and h are used to show whether the vegetation is shrubby, arboreal, or herbaceous. In case all three types of plants occur, the letter m indicates a fence row of mixed types. In farm-game areas, the fence row often forms one of the important elements of permanent cover and should therefore be indicated on the cover map.

Timber density also is indicated by vertical lines (|, ||, |||) accompanied by the type symbol and age class. Timber age is expressed by age classes and indicated on the cover map by arabic numbers. For example, the 0–10 year age class is denoted by 1, 11–20 by 2, 21–40 year age class by 3, and so on.

From a wildlife management aspect, the younger age classes are the most important. Food is more abundant and the vegetation provides better protective cover. It is for these reasons that the first 20 years of a stand are divided into the 0–10 and 11–20 year age groups. The remainder of the age classes are separated by 20 year intervals. Reproduction, and underbrush or shrub density is expressed by 1, 2, or 3 horizontal lines such as B6≡.

The tree association symbols indicate first the type, then density and age

class such as B8.11.4. This type frequently contains an understory of shrubs, so the complete symbol appears as $\frac{\text{B8.11.4.}}{\text{B6}=}$. The uses of the symbols are demonstrated in Plate 12. This map is a tract of typical farm-game territory in the highlands of eastern Connecticut. The entire area, 6,400 acres in size and managed as a State-regulated shooting ground, was cover-mapped during November and December in an actual field time of 40 hours, or an average of two sections per day. Cover mapping in Connecticut can be most efficiently done in the autumn after the leaves have fallen. Visibility is greatly increased and fence rows and shrub areas reveal their true cover value.

The method just outlined has a specific use only for southern New England. The principles of plant succession, however, may be employed as a basis for cover mapping in all sections of the country. The method is sufficiently flexible to permit any degree of accuracy or detail in making up the cover map. As methods of estimating available game food are perfected, such information should be included on the cover map.

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NOTES

As a result of conversations between representatives of The Wildlife Society and the American Wildlife Institute, it has been agreed that The Wildlife Society will arrange and administer the technical program for the Third North American Wildlife Conference, to be held probably in Baltimore, Md., about the middle of February. In order to discharge the Society's responsibility in this respect, President Bennitt has appointed a special program committee consisting of Ernest G. Holt (Chairman), Victor H. Cahalane, and W. L. McAtee, which will have the assistance of the Regional Representatives.

Members who wish places on the technical program of The Wildlife Conference should at once communicate the titles and reading time, and a brief synopsis of their papers, to Mr. Holt at 1653 Pennsylvania Avenue, N.W., Washington, D.C., and be prepared to submit their complete papers, ready for printing, at least thirty days prior to the opening of the conference, which will be definitely announced at an early date. One of the objectives of the new arrangement is the issuance of the Conference proceedings with a minimum of delay.

To ensure the highest possible standard of excellence and to keep the program within necessary limits of time and space, the committee reserves the right to accept or reject any paper offered, and to limit its length, in order to ensure a business-like conduct of the conference and equal opportunity to all participants. Authors will be given entire freedom of choice of material and manner of its presentation, but should make their papers as concise as consistent with lucidity; they should indicate what type of projection or illustrative apparatus, if any, will be needed.

The Secretary, Victor H. Cahalane, National Park Service, Washington, D.C., would appreciate being informed of the correct address of the members named below whose copy of the first issue of THE JOURNAL OF WILDLIFE MANAGEMENT has been returned by the Post Office Department from the address here given.

F. H. Bunce, Brandonburg, Kentucky.

Arroll L. Lamson, 393 Chapel St., New Haven, Connecticut.

Howard A. Merrill, Resettlement Administration, 401 Penn St., Huntingdon, Pennsylvania.

Probably most members of The Wildlife Society now receive Wildlife Review but those who do not may have their addresses added to the mailing list of this leaflet by applying to the U. S. Biological Survey, Washington, D. C. Wildlife Review is a mimeographed abstracting leaflet issued irregularly (4–5 times annually) that aims to bring to notice publications bearing on all phases of wildlife management, and which presents also occasional special articles, bibliographies, and notes and news of interest in the same connection.

Copies are still available of a 10-page mimeographed leaflet entitled "Preparing Scientific Manuscripts for the Biological Survey." It contains some historical notes on writing for that bureau and suggestions relative to composition. Address Technical Adviser, U. S. Biological Survey, Washington, D.C.

EMPLOYMENT SERVICE OF THE WILDLIFE SOCIETY

Purpose: This service will be operated as a department of the Journal for the dual purpose of publishing information concerning (1), available positions and (2), qualifications of persons seeking such positions.

Limitations: To conserve the time of officers, the Employment Service will be confined to announcements of openings and statements of the qualifications of candidates. All correspondence will be between prospective employers and applicants, and not with officers of the Society. Appointments to nearly all federal and many state positions in wildlife management are based upon Civil Service ratings. Aspirants should therefore apply to the U. S. Civil Service Commission, Washington, D. C., or to corresponding state organizations for announcements of examinations. Appointing officers are invited to report vacancies and new positions to the Employment Service.

Procedure: Each member will be entitled to one five-line statement of his education, qualifications, and preferences as to type of position in each volume. Additional lines will be charged for at the rate of 5 cents per line, and additional insertions at the same rate for all lines required.

All communications for the Employment Service should be sent to the Editor, W. L. McAtee, Bureau of Biological Survey, U. S. Dept. of Agriculture, Washington, D. C.

ERICKSON, ARNOLD B., 2828-32d Ave. S., Minneapolis, Minnesota. B.S. University of Minn. 1935; M.A. Minnesota 1937. Major zoology; minors wildlife management and bacteriology. Employed 6 months in St. Croix Recreational Demonstration Project as student technician, wildlife. Position desired: teaching, research, or field work in wildlife management.

GOODRUM, PHIL D., CCC Camp Educational Adviser, Trinity, Texas. *Education:* M.S. work in biology (wildlife management) at A. and M. College, Texas, completed except for writing thesis. *Experience:* 17 months part time field research on gray and fox squirrels under the direction of Dr. Walter P. Taylor; 5 years teaching biology; 18 months teaching wildlife management and general forestry to CCC men. Prefer wildlife research or teaching.

MCCANN, LESTER J., 3473 Emerson Ave. N., Minneapolis, Minnesota. B.S. University of Minn. 1936. Course included game management, forestry, and correlated subjects. Employment in practical field work in conservation biology especially desired.

MACLULICH, D. A., 144 Mavety Street, Toronto 9, Ontario, Canada. B.Sc.F. Toronto 1931, Ph.D. Toronto 1937; research on fluctuations in population of varying hares; graduate courses in bacteriology and immunology; bacteriology of hare; hospital bacteriology. Possible fields of work: research, teaching or practice, in wildlife management, forestry, zoology or bacteriology.

RIDDLE, DAVID, R. D. 1, Mexico, N. Y. Four years training Hamilton College and University of Wisconsin; no degree. Employment in wildlife management on Allegheny National Forest terminated by lack of funds. Position desired with any wildlife program.

SMITH, LESTER W., 60 Cottage St., Meriden, Connecticut. Naturalist experienced in care of bird sanctuaries, trained also in ornamental gardening and forestry; desires superintendency of estate, sanctuary, or other place where wildlife is a leading consideration. Best references as to ability, habits, and character.